**Angol nyelvű tárgyleírások**

**Basics in science**

**Tárgy neve: Map Projections 1 L**

Tárgyfelelős neve: Dr. Kerkovits Krisztián

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Complex knowledge of the general geographical, cartogrregaphic, planning, mathematical and informatic principles, rules, relationships required for the practice of geoinformatics

- Knowledge of the current theories, models and literature of geoinformatics based on scientific results. He/she is aware of the possible development directions and limits of the field of geoinformatics.

- In his/her native language, he/she confidently uses the conceptual system and terminology describing natural processes and can adapt it to the conceptual framework of geoinformatics.

b, abilities

- Ability to interpret complex professional problems in the field of geoinformatics, to explore the necessary theoretical and practical background and to solve problems.

- Ability to initiate cooperation with design and development professionals and end users of geoinformatics results.

- Ability to use the professional vocabulary of geoinformatics in his/her mother tongue and English.

c, attitude

- Monitors professional and technological developments in the field of geoinformatics and the labour market trends.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma:

* Coordinate systems on surfaces of revolution
* Introduction to spherical geometry
* Navigation along geodesics and rhumb lines
* Ellipsoidal geometry
* Fundamental tasks of geodesy
* General properties, attributes, and classification of map projections
* The theory of map distortions, Tissot's theorem
* Relationship between formulae of projections and distortions
* Distorted maps: cartograms, focussed projections
* Perspective azimuthal projections: vertical, gnomonic, orthographic, stereographic
* Non-persp. azimuthal projections: equidistant, Lambert, Ginzburg, UPS, Amersfoort, Roussilhe
* Perspective cylindrical projections: central, Gall, Braun, Lambert
* Non-perspective cylindrical projections: Plate Carrée, Cassini, Mercator, Miller, Gall–Peters
* Ellipsoidal cylindrical projections: Cassini–Soldner, Gauss–Krüger, Hotine, EOV, Web Mercator
* Aphylactic conic projections: perspective, De L'Isle, Mendeleyev, Ptolemy I.
* Equal-area & conformal conic projections: Lambert, Albers, Křovák
* Transformation between reference systems
* Map projections in the GIS

A számonkérés és értékelés rendszere: oral and/or written exam.

Kötelező irodalom:

* Snyder, J. P.: Map projections: A working manual U. S. Government Printing Office. Washington D.C. 397 p., 1987 ISBN: 9781782662228
* Fenna, D.: Cartographic Science: A Compendium of Map Projections, with Derivations. CRC Press. Boca Raton, FL. 504 p, 2007 ISBN: 9780849381690

Ajánlott irodalom

* Snyder, J. P.; Voxland, P. M.: An album of map projections. U. S. Government Printing Office. Washington D.C. 249 p. 1989 DOI: 10.3133/pp1453
* Grafarend, E. W., Krumm, F. W.: Map Projections: Cartographic Information Systems. Springer. Berlin. 714 p. 2006 ISBN: 9783540367024

**Tárgy neve: Map Projections 1 P**

Tárgyfelelős neve: Dr. Kerkovits Krisztián

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Complex knowledge of the general geographical, cartographic, planning, mathematical and informatic principles, rules, relationships required for the practice of geoinformatics

- Knowledge of the current theories, models and literature of geoinformatics based on scientific results. He/she is aware of the possible development directions and limits of the field of geoinformatics.

- In his/her native language, he/she confidently uses the conceptual system and terminology describing natural processes and can adapt it to the conceptual framework of geoinformatics.

b, abilities

- Ability to interpret complex professional problems in the field of geoinformatics, to explore the necessary theoretical and practical background and to solve problems.

- Ability to initiate cooperation with design and development professionals and end users of geoinformatics results.

- Ability to use the professional vocabulary of geoinformatics in his/her mother tongue and English.

c, attitude

- Monitors professional and technological developments in the field of geoinformatics and the labour market trends.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma:

* Basic planar geometry. Data of different ellipsoids
* Fundamental tasks of geodesy
* Calculating Molodensky transform parameters
* Georeferencing new and old maps
* MGRS, polynomial transform

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* Snyder, J. P.: Map projections: A working manual U. S. Government Printing Office. Washington D.C. 397 p., 1987 ISBN: 9781782662228
* Fenna, D.: Cartographic Science: A Compendium of Map Projections, with Derivations. CRC Press. Boca Raton, FL. 504 p, 2007 ISBN: 9780849381690

Ajánlott irodalom

* Snyder, J. P.; Voxland, P. M.: An album of map projections. U. S. Government Printing Office. Washington D.C. 249 p. 1989 DOI: 10.3133/pp1453
* Grafarend, E. W., Krumm, F. W.: Map Projections: Cartographic Information Systems. Springer. Berlin. 714 p. 2006 ISBN: 9783540367024

**Tárgy neve: Environmental systems**

Tárgyfelelős neve: Dr. Varga Zsófia Krisztina

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Knowledge of the interrelationships and interactions between geospheres

- Knowledge about the functioning of the major Earth systems

- Knowledge on the impact of human activities on Earth systems (including impacts on exogenous cycles)

b, abilities

- Confidently use concepts and terminology related to environmental systems in their mother tongue

- Ability to recognise and interpret the structure of environmental data

- Critical use of scientific sources

- Ability to identify and discuss environmental problems

c, attitude

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma: Fundamentals of systems theory and the structure of the Earth systems. Fundamentals of Network Science: negative and positive feedback in the environment. Changes in the global terrestrial systems. Cycles in the Earth systems and their impact on the earth's surface and society. Biogeochemical cycles in geospheres: atmosphere and hydrosphere interactions; the global carbon cycle; the oxygen cycle and ozone depletion, the global nitrogen cycle. The climate system and climate change: natural and anthropogenic climate change. Opportunities and limitations of the human society in the terrestrial systems.

A számonkérés és értékelés rendszere: oral and/or written exam.

Kötelező irodalom:

* David Huddart, Tim Stott: Earth Environment Past, Present and Future. Wiley-Blackwell. 2010.
* Kenneth Hamblin, Eric Christiansen: Earth’s Dynamic System, Prentice Hall. 2003.

Ajánlott irodalom:

* Huggett, Richard J.: Climate, Earth Processes and Earth History. Springer. 1991.
* Haggett, Peter. Geography: A Global Synthesis. Pearson Education, 2001.

**Tárgy neve: Geostatistics – Geomathematics**

Tárgyfelelős neve: Dr. Pál Márton

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Complex knowledge of the general geographical, cartographic, planning, mathematical and informatic principles, rules, relationships required for the practice of geoinformatics, especially in the following topics: geographical and spatial data collection at various scales;

- Spatial and temporal data analysis; data management

b, abilities

- Ability to interpret complex professional problems in the field of geoinformatics, to explore the necessary theoretical and practical background and to solve problems.

- Ability to initiate cooperation with design and development professionals and end users of geoinformatics results.

c, attitude

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

d) autonomy and responsibility:

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma: The aim of the course is to familiarise the student with the best known and most commonly used methods of geostatistics and geomathematics.

Variogram studies and kriging. Computations with the most important exploratory multivariate data analysis methods: cluster, discriminant and principal component and factor analysis. Basics of time series analysis: smoothing, decomposition methods, trend and periodicity. Basics of spectral analysis.

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* MCBRIDE, Graham B. Using statistical methods for water quality management: issues, problems and solutions. John Wiley & Sons, 2005., ISBN: 9780471470168
* ROGERSON, Peter. Statistical methods for geography. Sage, 2014., ISBN: 9781446295731
* MCCARROLL, Danny: Simple Statistical Tests for Geography, Taylor & Francis, 2016, ISBN 9781498758819

Ajánlott irodalom:

* DAVIS, John C.; SAMPSON, Robert J. Statistics and data analysis in geology. New York: Wiley, 2002., ISBN: 9780471172758
* ROGERSON, Peter. Spatial Statistical Methods for Geography, Sage Publications, 2021, ISBN 9781529707458
* ACEVEDO Miguel F.: Data Analysis and Statistics for Geography, Environmental Science, and Engineering, Taylor & Francis, 2019, ISBN 9780367866792

**Economic, legal and human science**

**Tárgy neve: Spatial-social data sources**

Tárgyfelelős neve: Dr.José Jesús Reyes Nunez

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Complex knowledge of the general geographical, cartographic, planning, mathematical and informatic principles, rules, relationships required for the practice of geoinformatics, especially in the following topics: geographical and spatial data collection at various scales; use of cartographic processes; knowledge of geographical and spatial processes; collection, editing and analysis of spatial data; remote sensing, photogrammetry, geostatistics, modelling, visualization, and geoinformatics system building.

- Comprehensive knowledge and understanding of the key relationships and concepts in the field of geoinformatics, in particular in the following areas: geolocation data collection technologies, 2- and 3-dimensional geoinformatics modelling, geovisualization, spatial data infrastructures, geoinformatics programming and application development, vector and raster geoinformatics, digital image processing, web-based geoinformatics solutions, geoinformatics databases, applied geoinformatics systems.

- Comprehensive knowledge of the problem-solving principles, methodology and processes of the planning, development and operation processes of the geoinformatics field

b, abilities

- Ability to interpret complex professional problems in the field of geoinformatics, to explore the necessary theoretical and practical background and to solve problems.

- Ability to interpret geographical/spatial phenomena, processes and information, and to plan, organize, manage and control processes in the field of geoinformatics.

- Ability to collect data independently and organize spatial data into a database, as well as to organize the data with the tools of geoinformatics. Ability to perform operations and models with independently organized databases.

c, attitude

- Committed to environmentally conscious behaviour in his/her field and laboratory activities.

- Monitors professional and technological developments in the field of geoinformatics and the labour market trends.

- Committed to adhering to and making others adhere to quality requirements.

- Open to professional cooperation with professionals working in related fields.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

Az oktatás tartalma: The course introduces the access, use and correct interpretation of socio-economic territorial databases available in electronic forms, which can also be used for GIS visualisation and analysis. The course deals with the spatial resolution of different socio-economic phenomena and with the related public or commercially available statistical data sources. In the first part of the course a brief historical introduction and a review of the basic theoretical aspects of spatial and socio-economic data are given for the students. After it, they learn how to fit data needs to the existing international, regional and national statistical databases. Different examples of spatial and socio-economic databases are examined, which can be accessed online. In the second part of the course, the students also have the opportunity to test which options are offered to visualize the downloaded data. The use of online applications that are freely accessible at least in part will be taught for the students, who will be able to represent text and numeric data with different solutions: diagrams, word- and data-based clouds, thematic maps and story maps.

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* The pdf files created by the lecturer with the websites, databases and data visualisation solutions presented in the classroom.

Ajánlott irodalom:

* UNData API Manual: <https://data.un.org/Host.aspx?Content=API>
* EUROSTAT publications: <https://ec.europa.eu/eurostat/web/main/publications>
* HCSO (KSH) publications: <https://www.ksh.hu/apps/shop.main?p_lang=EN>
* How to create word clouds? (Tutorials developed for WordArt): <https://wordart.com/tutorials>
* Questions related to the use of Datawrapper: <https://www.datawrapper.de/faq>
* Creating maps in Map Viewer: <https://learn.arcgis.com/en/paths/mapping-and-visualization/>
* Start creating ArcGIS StoryMaps: <https://www.esri.com/en-us/arcgis/products/arcgis-storymaps/resources>

**Tárgy neve: Fundamentals of Economics**

Tárgyfelelős neve: Dr. Székely -Doby András

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Complex knowledge of the general geographical, cartographic, planning, mathematical and informatic principles, rules, relationships required for the practice of geoinformatics, especially in the following topics: geographical and spatial data collection at various scales; use of cartographic processes; knowledge of geographical and spatial processes; collection, editing and analysis of spatial data

b, abilities

- Ability to interpret geographical/spatial phenomena, processes and information, and to plan, organize, manage and control processes in the field of geoinformatics.

- Ability to initiate cooperation with design and development professionals and end users of geoinformatics results.

c, attitude

- Monitors professional and technological developments in the field of geoinformatics and the labour market trends.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma: The course provides an introduction to the colorful and exciting world of economics. By exploring the fundamental ways of economic thinking, students will gradually learn the most important concepts, principles, and approaches of the subject. The main focus is on presenting, understanding, and modelling some basic economic problems for those who have not learnt economics before. In the first semester, we will study microeconomics, which examines processes from the point of view of the individual actors. Course outline:

* Economics as a social science
* Ten principles of economics. Thinking like an economist
* Interdependence and the gains from trade
* The market forces of supply and demand
* Elasticity and its Applications
* Supply, demand, and government policies
* Consumers, producers and the efficiency of markets
* Externalities, public goods, and common resources
* The costs of production, firms in competitive markets
* Monopoly
* Economics of information, game theory

A számonkérés és értékelés rendszere: oral and/or written exam.

Kötelező irodalom:

* N. Gregory Mankiw: Principles of Economics, Ninth Edtion, Cengage Learning, Inc., Boston MA, 2021 (previous editions are equally good).

Ajánlott irodalom:

* Hirshleifer, J., Glazer, A., & Hirshleifer, D. (2005). Price Theory and Applications: Decisions, Markets, and Information (7th Edition). Cambridge University Press, Cambridge. ISBN: 978521523424
* Stock, W. (2012). Introduction to Economics: Social Issues and Economic Thinking. John Wiley & Sons, New Jersey. ISBN: 9780470574782
* Dasgupta, P.: Economics (2007). A Very Short Introduction. Oxford University Press, Oxford. ISBN: 9780192853455
* Steger, M. (2020). Globalization: A Very Short Introduction (Very Short Introductions). Oxford University Press, Oxford. ISBN: 9780198849452

**Basics in geoinformatics**

**Tárgy neve: Data mining and cloud-based solutions**

Tárgyfelelős neve: Dr. Ungvári Zsuzsanna

Tárgyfelelős tudományos fokozata: habil. PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Comprehensive knowledge of the problem-solving principles, methodology and processes of the planning, development and operation processes of the geoinformatics field, especially in the following areas: database management, Big Data data-mining, primary and secondary data collection, Earth observation, spatial and temporal data analysis, modelling and simulation of processes, network analysis, 3-dimensional modelling, geovisualization, geostatistical solutions, web-based geoinformatics services, spatial services development, geoinformatics programming, development of geospatial applications, open-source geoinformatics.

- Understandings, knowledge and application of mobile field, laboratory and practical materials, tools and methods of geoinformatics.

b, abilities

- Ability to collect data independently and organize spatial data into a database, as well as to organize the data with the tools of geoinformatics. Ability to perform operations and models with independently organized databases.

- Ability to recognize and apply new problem-solving methods and procedures in his/her field and apply what he/she has learnt in a diverse, multidisciplinary environment.

c, attitude

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Open to professional cooperation with professionals working in related fields.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma:

Main topics:

1. Crowdsourcing in spatial data. Data quality, evaluation. Comparing crowdsourced data with national databases. Data protection.
2. Tools and techniques in Data Mining.
3. The OpenStreetMap database. Copyright and licenses. Downloading data from the OSM with Overpass Turbo API.
4. Usage and import of spatial data in geoinformatics software (QGIS, ArcGIS). Building databases from downloaded data.
5. Geocoder applications in the web. Getting data from web with scripts.
6. Automations in data mining with Python.
7. Data mining from free and open databases.
8. Application of AI in data mining in geoinformatics

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* Pang-Ning Tan, Michael Steinbach, Vipin Kumar: Introduction to Data Mining. Pearson Education Inc., 2019 ISBN: 9780133128901, 0133128903

<https://www-users.cs.umn.edu/~kumar001/dmbook/index.php#chapters>

* OpenStreetMap WIKI: <https://wiki.openstreetmap.org/wiki/Main_Page>., 2020

Ajánlott irodalom:

* Arsanjani, Zipf, Mooney, Helbich (eds.): OpenStreetMap in GIScience: Experiences, Research, and Applications. Springer, 2015. ISBN: 9783319142807
* Ian H. Witten, Eibe Frank, Mark A. Hall, Christopher J. Pal: Data mining. Practical Machine Learning Tools and Techniques. ELSEVIER SCIENCE & TECHNOLOGY. 2017. ISBN 9780128042915

<https://www.cs.waikato.ac.nz/~ml/weka/book.html>

**Tárgy neve: Geospatial algorithms L**

Tárgyfelelős neve: Dr. Gede Mátyás

Tárgyfelelős tudományos fokozata: habil. PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Knowledge of the current theories, models and literature of geoinformatics based on scientific results. He/she is aware of the possible development directions and limits of the field of geoinformatics.

- Comprehensive knowledge and understanding of the key relationships and concepts in the field of geoinformatics, in particular in the following areas: geovisualization, geoinformatics programming and application development, vector and raster geoinformatics, digital image processing.

b, abilities

- Ability to interpret complex professional problems in the field of geoinformatics, to explore the necessary theoretical and practical background and to solve problems.

- Ability to recognize and apply new problem-solving methods and procedures in his/her field and apply what he/she has learnt in a diverse, multidisciplinary environment.

- Ability to use the professional vocabulary of geoinformatics in his/her mother tongue and English.

c, attitude

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma:

The course introduces students to fundamental algorithms and data structures in computer science, which are also widely used in geoinformatics. The second half of the course focuses on the geospatial field and takes an outlook on well-known geospatial algorithms and data structures.

1. Basic data structures: array, linked list, stack, queue. Priority queue, heap data structure.
2. Basic algorithms: summation, counting, maximum selection, conditional variants, linear search, logarithmic search.
3. Sorting: bubble sort, insertion sort, maximum sort, quicksort, merge sort, complexity analysis.
4. Graph representation (adjacency matrix, edge list). Graph traversal (BFS, DFS).
5. Minimum cost path graph algorithms (Dijkstra, Bellman-Ford).
6. Minimum spanning trees (Red-Blue rules, Prim algorithm, Kruskal algorithm)
7. Scalar indexing: binary tree, search tree, AVL-tree, B (2-3) tree
8. Spatial indexing: grid index, kd-tree, adaptive kd-tree, quadtree, R-tree
9. Topological algorithms: Crossing Number, Shamos-Hoey, Bentley-Ottman, Greiner-Hormann.
10. Topological data structures: winged-edge, half-edge.
11. Convex hull algorithms: Jarvis’s march, Graham’s scan, Quickhull, Chan’s algorithm
12. Clustering and classification: K-means, ISODATA
13. Possibilities and risks of using AI-generated code: raising students' awareness of the limitations of typing assistants integrated into various development environments, the characteristics of code generated by large language models, and their potential errors.

A számonkérés és értékelés rendszere: oral and/or written exam.

Kötelező irodalom:

* T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein: Introduction to Algorithms, The MIT Press, 2009, ISBN: 9780262033848
* H. Samet: The Design and Analysis of Spatial Data Structures, Addison-Wesley, 1994, ISBN: 9780201502558

Ajánlott irodalom

* P. Rigaux, M. O. Scholl, A. Voisard: Spatial Databases: With Application to GIS, Morgan Kaufmannn, 2001, ISBN: 9781558605886
* M. de Berg, O. Cheong, M. van Kreveld, M. Overmars: Computational Geometry, Springer, 2008, ISBN: 9783540779735

**Tárgy neve: Geospatial algorithms P**

Tárgyfelelős neve: Dr. Gede Mátyás

Tárgyfelelős tudományos fokozata: habil. PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Knowledge of the current theories, models and literature of geoinformatics based on scientific results. He/she is aware of the possible development directions and limits of the field of geoinformatics.

- Comprehensive knowledge and understanding of the key relationships and concepts in the field of geoinformatics, in particular in the following areas: geovisualization, geoinformatics programming and application development, vector and raster geoinformatics, digital image processing.

b, abilities

- Ability to interpret complex professional problems in the field of geoinformatics, to explore the necessary theoretical and practical background and to solve problems.

- Ability to recognize and apply new problem-solving methods and procedures in his/her field and apply what he/she has learnt in a diverse, multidisciplinary environment.

- Ability to use the professional vocabulary of geoinformatics in his/her mother tongue and English.

c, attitude

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma:

The course introduces students to fundamental algorithms and data structures in computer science, which are also widely used in geoinformatics. The second half of the course focuses on the geospatial field and takes an outlook on well-known geospatial algorithms and data structures.

1. Introduction to Python. Literals and variables, data types, User input management. Control structures (sequences, conditional executions, iterations). Exception handling (try & except).
2. Functions: built-in functions, function definition, arguments & parameters, return value.
3. Collection data structures in Python: lists, dictionaries, tuples, sets.
4. Basic algorithms: summation, counting, maximum selection, conditional variants, linear search, logarithmic search.
5. Sorting: bubble sort, insertion sort, maximum sort, quicksort, merge sort, complexity analysis.
6. Tabular data processing (CSV, Excel files), pandas library. Plotting and diagram visualization of scalar data (matplotlib library).
7. Spatial data management: vector formats (geopandas library), raster formats (rasterio library)
8. Graph representation (adjacency matrix, edge list). Graph traversal (BFS, DFS).
9. Minimum cost path graph algorithms (Dijkstra, Bellman-Ford). Priority queue, heap data structure.
10. Minimum spanning trees (Red-Blue rules, Prim algorithm, Kruskal algorithm)
11. Scalar indexing: binary tree, search tree, AVL-tree, B (2-3) tree
12. Spatial indexing: grid index, kd-tree, adaptive kd-tree, quadtree, R-tree
13. Topological algorithms: Crossing Number, Shamos-Hoey, Bentley-Ottman, Greiner-Hormann.
14. Topological data structures: winged-edge, half-edge.
15. Convex hull algorithms: Jarvis’s march, Graham’s scan, Quickhull, Chan’s algorithm
16. Clustering and classification: K-means, ISODATA
17. Possibilities and risks of using AI-generated code: raising students' awareness of the limitations of typing assistants integrated into various development environments, the characteristics of code generated by large language models, and their potential errors.

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein: Introduction to Algorithms, The MIT Press, 2009, ISBN: 9780262033848
* H. Samet: The Design and Analysis of Spatial Data Structures, Addison-Wesley, 1994, ISBN: 9780201502558

Ajánlott irodalom

* P. Rigaux, M. O. Scholl, A. Voisard: Spatial Databases: With Application to GIS, Morgan Kaufmannn, 2001, ISBN: 9781558605886
* M. de Berg, O. Cheong, M. van Kreveld, M. Overmars: Computational Geometry, Springer, 2008, ISBN: 9783540779735
* E. Matthes: Python Crash Course, No Starch Press, 2015, ISBN: 9781593279288

**Tárgy neve: Geoinformatics**

Tárgyfelelős neve: Dr. Jung András

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Complex knowledge of the general geographical, cartographic, planning, mathematical and informatic principles, rules, relationships required for the practice of geoinformatics

- Knowledge of the current theories, models and literature of geoinformatics based on scientific results. He/she is aware of the possible development directions and limits of the field of geoinformatics.

- Comprehensive knowledge and understanding of the key relationships and concepts in the field of geoinformatics

- Comprehensive knowledge of the problem-solving principles, methodology and processes of the planning, development and operation processes of the geoinformatics field

b, abilities

- Ability to interpret complex professional problems in the field of geoinformatics, to explore the necessary theoretical and practical background and to solve problems.

- Ability to recognize and apply new problem-solving methods and procedures in his/her field and apply what he/she has learnt in a diverse, multidisciplinary environment.

- Ability to use the professional vocabulary of geoinformatics in his/her mother tongue and English.

c, attitude

- Monitors professional and technological developments in the field of geoinformatics and the labour market trends.

- Committed to environmentally conscious behaviour in his/her field and laboratory activities.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma: The aim of the course is to overview the most commonly used concepts in the application of GIS and to explain their context. The topics covered during the semester are: vector and raster data systems; topologies and types of geodatabases and an overview of the OGC standard; dimensions and attributes; the relationship between databases and visualisation and geoinformatics modelling; geoinformatics in society, data communication; interpretation of geoinformatics data (principal component analysis, BigData, machine learning, etc.).

A számonkérés és értékelés rendszere: oral and/or written exam.

Kötelező irodalom:

* Kemp, K. (Ed.). (2008). Encyclopedia of geographic information science. Sage. ISBN 978-1-4129-1313-3
* Lemmens, M. (2011). Geo-information: technologies, applications and the environment (Vol. 5). Springer Science & Business Media. ISBN 978-94-007-1666-7

Ajánlott irodalom:

* Karimi, H. A. (Ed.). (2014). Big Data: techniques and technologies in geoinformatics. Crc Press.
* Egenhofer, M. J., Clarke, K. C., Gao, S., Quesnot, T., Franklin, W. R., Yuan, M., & Coleman, D. (2016). Contributions of GIScience over the past twenty years. Advancing geographic information science: The past and the next twenty years, 9-34

**Tárgy neve: Measurements and data collection**

Tárgyfelelős neve: Dr. Kovács Béla

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Theoretical/practical knowledge of satellite positioning and navigation systems

- Knowledge of field data collection equipment

- Theoretical and practical knowledge of general tools for geoinformatics and geodesy

b, abilities

- Ability to orientate spatially with or without instruments

- Ability to interpret (special) maps

- Ability to program and operate field data collection equipment

- Ability to locate and navigate with and without instruments

- Ability to select and locate a sampling site

- Ability to carry out planned measurements using ground and airborne (e.g. GNSS instrument, drone) field data collection equipment

c, attitude

- Monitors professional and technological developments in the field of geoinformatics and the labour market trends.

- Committed to environmentally conscious behaviour in his/her field and laboratory activities.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma:

* planning and execution of field measurements and data collection
* objective and subjective sources of danger, emergency management
* map reading, use of maps, orienteering on field
* theory and practice of GNSS
* sub-metre and sub-mm level satellite-based positioning
* errors in field measurements and how to eliminate/reduce them
* mapping of sampling locations and GI data collection
* how to navigate on field
* UAV/drones in fieldwork
* mobile mapping equipment and solutions

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

|  |
| --- |
| * Hofmann-Wellenhof, Bernhard, Lichtenegger, Herbert, Wasle, Elmar, 2008. GNSS – Global Navigation Satellite Systems, Springer-Verlag Wien, ISBN: 978-3-211-73012-6
* Esmat Bekir: Introduction to Modern Navigation Systems,World Scientific Publishing Company, 2007
* Mohinder S. Grewal, Lawrence R. Weill, Angus P. Andrews: Global Positioning Systems, Inertial Navigation, and Integration, Wiley, 2007, ISBN: 978-0-470-09971-1
 |

Ajánlott irodalom:

* Laurie Tetley etal: Electronic Navigation Systems, Taylor & Francis, 2012, ISBN: 978-0-7506-5138-7
* GIS – Collecting Field Data (<https://guides.library.yale.edu/GIS/Collector>)

**Tárgy neve: Spatial Databases**

Tárgyfelelős neve: Dr. Ungvári Zsuzsanna

Tárgyfelelős tudományos fokozata: habil. PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Comprehensive knowledge and understanding of the key relationships and concepts in the field of geoinformatics, in particular in the following areas: geolocation data collection technologies, 2- and 3-dimensional geoinformatics modelling, geovisualization, spatial data infrastructures, geoinformatics programming and application development, vector and raster geoinformatics, digital image processing, web-based geoinformatics solutions, geoinformatics databases, applied geoinformatics systems.

b, abilities

- Ability to collect data independently and organize spatial data into a database, as well as to organize the data with the tools of geoinformatics. Ability to perform operations and models with independently organized databases.

- Ability to create geoinformatics systems to support and assist decision makers.

- Ability to recognize and apply new problem-solving methods and procedures in his/her field and apply what he/she has learnt in a diverse, multidisciplinary environment.

- Ability to use the professional vocabulary of geoinformatics in his/her mother tongue and English.

c, attitude

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma:

Main topics:

Introduction to PostgreSQL (where clauses, simple and aggregating functions join among tables /left, right, inner, outer joins/, subqueries)

Spatial data storing in PostGIS. WKT and WKB format, EWKT. Data conversion functions, handling projections. Spatial indexing. Graphic visualization of spatial data.

Measuring and calculation object sizes (for example: distances, area, perimeter, azimuth, bounding boxes)

Geometry processing: buffer, centroid, convex and concave hull, line simplification, line smoothing. Creating different types of geometries.

Geoprocessing in PostGIS (difference, intersection, symmetrical difference, union), topological evaluation

Complex geoprocessing in PostGIS

Creating, modifying and deleting spatial databases.

Working with raster data: satellite images and digital elevation models (data storing, georeferencing, data conversion, multi-channel satellite image, raster mathematics)

Developing simple websites visualizing spatial data.

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* PostGIS Documentation: <https://postgis.net/documentation/>
* Nagy G.: Spatial databases online lecture notes 1-6. chapters. <https://regi.tankonyvtar.hu/hu/tartalom/tamop425/0027_SDO1/index.html>

<https://regi.tankonyvtar.hu/hu/tartalom/tamop425/0027_SDO2/index.html>

<https://regi.tankonyvtar.hu/hu/tartalom/tamop425/0027_SDO3/index.html>

<https://regi.tankonyvtar.hu/hu/tartalom/tamop425/0027_SDO4/index.html>

[https://regi.tankonyvtar.hu/hu/tartalom/tamop425/0027\_SDO5/index.html](https://regi.tankonyvtar.hu/hu/tartalom/tamop425/0027_SDO5/index.html?fbclid=IwAR2oaZN3LjxCGMqXbexOQzu6sotWYNXT3r0OfhDNVHtWA3jptgZHiDmQC78)

<https://regi.tankonyvtar.hu/hu/tartalom/tamop425/0027_SDO6/index.html>

Ajánlott irodalom:

* PostgreSQL Documentation: <https://www.postgresql.org/docs/>
* Obe.E Regina: PostGIS in Action. Shelter Island, Manning, 2015. ISBN: 9781935182269

**Tárgy neve: Digital terrain models**

Tárgyfelelős neve: Dr. Ungvári Zsuzsanna

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Geographic and spatial data collection at different scales, use of cartographic procedures

- Geostatistics, 2- and 3-dimensional geographic modelling, visualization

b, abilities

- Perform operations and model building with self-organised databases.

- Ability to creatively and methodically process, evaluate, interpret and analyse measurement results and draw conclusions from them.

- Ability to use the professional vocabulary of geoinformatics in his/her mother tongue and English.

c, attitude

- Monitors professional and technological developments in the field of geoinformatics and the labour market trends.

- Committed to environmentally conscious behaviour in his/her field and laboratory activities.

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

- In accordance with his/her professional competencies, he/she can be assigned with responsibility for development and operation in geoinformatics systems.

Az oktatás tartalma:

Introduction to digital terrain models.
 Concept of digital terrain models, varieties, GRID and TIN models.
 Application of digital terrain models.
 Different base data to create digital terrain models (contour maps, GPS, radar, LiDAR).
 DTM databases (SRTM, ASTER, GMTED, national datasets).
 Digitization practice.
 Theory of interpolations (Linear interpolation, kriging, etc.)
 DTM visualisations.
 Derived maps (slope, aspect, curvature, etc.) practice and theoretical background.
 DTM error types, detection and correction.

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* Li Z, Zhu C, Gold C (2005): Digital Terrain Modeling. Principles and Methodology. CRC Press, 340 p., ISBN 9780415324625.
* Rabus, B., Eineder, M., Roth, A., Bamler, R. (2003): The shuttle radar topography mission – a new class of digital elevation models acquired by spaceborne radar. ISPRS Journal of Photogrammetry and Remote Sensing, 57(4):241-262.

Ajánlott irodalom:

* Burrough, P.A. – McDonnell, R.A (1998): Principles of Geographical Information Systems. – Oxford University Press, Oxford, 306 p., ISBN: 9780198742845
* Florinsky IV (2016): Digital Terrain Analysis in Soil Science and Geology. Academic Press, Elsevier, ISBN 978-0-12-804632-6
* Maune DF, Nayegandhi A (edt) (2007): Digital Elevation Model Technologies and Applications: The DEM Users Manual. ASPRS, 2nd edition, ISBN 978-1570830822
* Wilson J. P., Gallant J. C. (eds.) (2000): Terrain Analysis: Principles and Application. John Wiley & Sons, USA

**Tárgy neve: Satellite Remote Sensing P**

Tárgyfelelős neve: Dr. Varga Zsófia Krisztina

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge:

- Complex knowledge of the general geographical, cartographic, planning, mathematical and informatic principles, rules, relationships required for the practice of geoinformatics, especially in the following topics: geographical and spatial data collection at various scales; use of cartographic processes; knowledge of geographical and spatial processes; collection, editing and analysis of spatial data; remote sensing, photogrammetry, geostatistics, modelling, visualization, and geoinformatics system building

- Comprehensive knowledge and understanding of the key relationships and concepts in the field of geoinformatics, in particular in the following areas: geolocation data collection technologies, 2- and 3-dimensional geoinformatics modelling, geovisualization, spatial data infrastructures, geoinformatics programming and application development, vector and raster geoinformatics, digital image processing, web-based geoinformatics solutions, geoinformatics databases, applied geoinformatics systems.

b, abilities

- Ability to interpret geographical/spatial phenomena, processes and information, and to plan, organize, manage and control processes in the field of geoinformatics.

- Ability to collect data independently and organize spatial data into a database, as well as to organize the data with the tools of geoinformatics. Ability to perform operations and models with independently organized databases.

- Ability to design value-added services, especially concerning Earth observation.

c, attitude

- Monitors professional and technological developments in the field of geoinformatics and the labour market trends.

- Committed to adhering to and making others adhere to quality requirements.

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields

Az oktatás tartalma: Visual interpretation of optical band remote sensing satellites images (LANDSAT, SPOT, IRS, Sentinel, etc.). Computer aided image interpretation. Image interpretation of super high resolution satellites (IKONOS, QuickBird, WorldView, etc.). Image transformation. Re-sampling methods. Image correction procedures. Basic image enhancement techniques. Convolution filters. Index calculations, vegetation indices. Types of classification, clustering, supervised classification.

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* William Emery and Adriano Camps: Introduction to Satellite Remote Sensing: Atmosphere, Ocean, Land and Cryosphere Applications; 860p., Elsevier Inc., 2017, ISBN 9780128092545
* Emilio Chuvieco: Fundamentals of Satellite Remote Sensing: An Environmental Approach (3rd Edition) 598 p. CRC Press, 2010 ISBN: 9781138583832

Ajánlott irodalom:

* Nicolas Baghdadi and Mehrez Zribi (ed.) Land Surface Remote Sensing in Urban and Coastal Areas 350 p., Elsevier Inc., 2017, ISBN 9781785481604
* Fu W., Ma J., Chen P., Chen F. (2020) Remote Sensing Satellites for Digital Earth. In: Guo H., Goodchild M.F., Annoni A. (eds) Manual of Digital Earth. Springer, Singapore. <https://doi.org/10.1007/978-981-32-9915-3_3>

**Tárgy neve: Map design and production L**

Tárgyfelelős neve: Dr. Zentai László

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Complex knowledge of the general geographical, cartographic, planning, mathematical and informatic principles, rules, relationships required for the practice of cartography

- Familiar with the specific tools of the geoinformatics discipline, learn the cartographic elements of field survey procedures, data management and analysis, effective cartographic representation solutions in a geoinformatics environment;

- Knowledge and use of spatial data collection technologies, their cartographic aspects and key elements.

b, abilities

- Ability to select the most effective cartographic tools and software to solve a given task, depending on its complexity;

- Ability to systematically process, evaluate, interpret and analyse the measurement results and to support the drawing of conclusions from these results in cartographic terms, and to visualise them in an optimal way;

- Ability with the acquired cartographic knowledge to carry out effective, user-oriented planning, development and consultancy tasks in the operation of GIS, decision support systems and expert systems.

c, attitude

- Open to professional cooperation with professionals working in related fields.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma: The map. The concept of map. Scale, projection, generalization, graphical legend. Classification of maps according to scale. Map types: base maps, general maps, thematic maps. Sources of map making.

Maps for the public. Types and concepts. General characteristics, scale and legend. Additions to maps: insets, name registers, search grids, alphabetical arrangement.

Map frame. Types of frames. Map model. Map extract. Form of the map sheet. Technical symbols on the map. Legend and explanation of symbols. The process and phases of map making.

Map content. Aspects of representation. Characteristics of objects and phenomena. Map elements. Layers of map content: relief, planimetric features, place names. Representation methods. Generalization: steps, guidelines, limits.

Relief. Representation of relief. Modern cartographic methods. Relationship between method, scale and map type. Planimetric features I. Drainage, elements and groups. Hydrographic objects. Representation of hydrographic features in various scales.

Planimetric features I. Borders. Categories of borders and their representation. Transportation features, their categories and representation. Land coverage. Representation of vegetation in various scales. Representation of land-use and geographical zones of vegetation cover. Representation of built-up areas and settlements.

Geographical names: Place names. Labelling of places. Writing systems. Names in Latin script. Types of place names and categories of their representation. Parts of names. Typography of labelling place names. Letter types and traditions of labelling. Names referring to points and point-like features. Settlement names. Hydrographic names of point elements. Names of characteristics geographical points (peaks, passes). Explanatory names. Names referring to areas. Hydrographic names referring to areas. Micro topographical names. Physical landscape regions in cartography. Names of historical-geographical regions. Administrative names. Names of states and administrative divisions. Names of protected areas. Names of linear elements. Hydrographic names of linear features. Representation of administrative names referring g to area and line. Names of public domains. Types of supplementary information on maps. Pictograms and their representation.

Atlases. Types of atlases. Atlases of map sheets. Atlases of separate maps. Editing atlases.

Historical maps. The use of historical maps. Types of historical maps. Spatial representation of historical events. Showing dynamism on a static base. Publications. Relationship between the legend of popular maps and historical maps. Real historical map.

Cartographic fieldwork. Reconnaissance. Maps for orientation on the terrain. Revising tourist maps. Updating city maps. Sources of updating and revision.

A számonkérés és értékelés rendszere: oral and/or written exam.

Kötelező irodalom:

* Kraak, M.-J., Ormeling, F. (2020) Cartography: Visualization of Geospatial Data. Fourth Edition. CRC Press. ISBN 9781138613959
* Brewer, C. A. (2015) Designing Better Maps: A guide for GIS users. First edition. Esri Press. ISBN: 9781589484405

Ajánlott irodalom:

* Crampton, J. W. (2011) Mapping: A Critical Introduction to Cartography and GIS. First edition. Wiley-Blackwell. ISBN-13: 978-1405121729
* Field, K. (2018) Cartography. First edition. Esri Press. ISBN-13: 978-1589484399
* Raisz, E. (1948) General Cartography. McGraw-Hill Book Company: New York.

**Tárgy neve: Map design and production P**

Tárgyfelelős neve: Dr. Reyes Nunez José Jesús

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Complex knowledge of the general geographical, cartographic, planning, mathematical and informatic principles, rules, relationships required for the practice of cartography

- Familiar with the specific tools of the geoinformatics discipline, learn the cartographic elements of field survey procedures, data management and analysis, effective cartographic representation solutions in a geoinformatics environment;

- Knowledge and use of spatial data collection technologies, their cartographic aspects and key elements.

b, abilities

- Ability to select the most effective cartographic tools and software to solve a given task, depending on its complexity;

- Ability to systematically process, evaluate, interpret and analyse the measurement results and to support the drawing of conclusions from these results in cartographic terms, and to visualise them in an optimal way;

- Ability with the acquired cartographic knowledge to carry out effective, user-oriented planning, development and consultancy tasks in the operation of GIS, decision support systems and expert systems.

c, attitude

- Open to professional cooperation with professionals working in related fields.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma:

Map types: base maps, general maps, thematic maps. Sources of map making.

Maps for the public. Types and concepts. General characteristics, scale and legend. Additions to maps: insets, name registers, search grids, alphabetical arrangement.

Map frame. Types of frames. Map model. Map extract. Form of the map sheet. Technical symbols on the map. Legend and explanation of symbols. The process and phases of map making.

Map content. Aspects of representation. Characteristics of objects and phenomena. Map elements. Layers of map content: relief, planimetric features, place names. Representation methods. Generalization: steps, guidelines, limits.

Relief. Representation of relief. Modern cartographic methods. Relationship between method, scale and map type. Planimetric features I. Drainage, elements and groups. Hydrographic objects. Representation of hydrographic features in various scales.

Planimetric features Borders. Categories of borders and their representation. Transportation features, their categories and representation. Land coverage. Representation of vegetation in various scales. Representation of land-use and geographical zones of vegetation cover. Representation of built-up areas and settlements.

Geographical names: Place names. Labelling of places. Writing systems. Administrative names. Names of states and administrative divisions. Names of protected areas. Names of linear elements. Hydrographic names of linear features. Representation of administrative names referring g to area and line. Names of public domains.

Atlases. Types of atlases. Atlases of map sheets. Atlases of separate maps. Editing atlases.

Historical maps. The use of historical maps. Types of historical maps. Spatial representation of historical events. Showing dynamism on a static base. Publications. Relationship between the legend of popular maps and historical maps. Real historical map.

Cartographic fieldwork. Reconnaissance. Maps for orientation on the terrain. Revising tourist maps. Updating city maps. Sources of updating and revision.

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* Kraak, M.-J., Ormeling, F. (2020) Cartography: Visualization of Geospatial Data. Fourth Edition. CRC Press. ISBN 9781138613959
* Brewer, C. A. (2015) Designing Better Maps: A guide for GIS users. First edition. Esri Press. ISBN: 9781589484405
* Kraak, Roth, Ricker, Kagawa, Le Sourd: Mapping for a Sustainable World, United Nations-ICA, 2021, DOI: <https://doi.org/10.18356/9789216040468>, ISBN (PDF): 9789216040468

Ajánlott irodalom:

* Crampton, J. W. (2011) Mapping: A Critical Introduction to Cartography and GIS. First edition. Wiley-Blackwell. ISBN-13: 978-1405121729
* Field, K. (2018) Cartography. First edition. Esri Press. ISBN-13: 978-1589484399
* Raisz, E. (1948) General Cartography. McGraw-Hill Book Company: New York.

**Tárgy neve: Vector-Based GIS (QGIS)**

Tárgyfelelős neve: Dr. Albert Gárpár

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Complex knowledge of the general geographical, cartographic, planning, mathematical and informatic principles, rules, relationships required for the practice of geoinformatics, especially in the following topics: geoinformatics system building

- Comprehensive knowledge of the problem-solving principles, methodology and processes of the planning, development and operation processes of the geoinformatics field

- Knowledge of the specific tools of geoinformatics, ability to apply field survey procedures, data management and analysis, and visualization solutions.

b, abilities

- Ability to interpret complex professional problems in the field of geoinformatics, to explore the necessary theoretical and practical background and to solve problems.

- Ability to creatively and methodically process, evaluate, interpret and analyse measurement results and draw conclusions from them.

- Ability to recognize and apply new problem-solving methods and procedures in his/her field and apply what he/she has learnt in a diverse, multidisciplinary environment.

c, attitude

- Monitors professional and technological developments in the field of geoinformatics and the labour market trends.

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma: The goal of this course is to show the basic tools and applications of open-source GIS exploiting the possibilities of the software QGIS and GRASS. Alongside user-level applications of vector raster and 3D systems, contemporary trends (mesh, topologic data structures) are considered, as well. Finally, smaller components (e. g. plugins) are developed on the system using the API of the software at a beginner level.

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* Sherman, G.: The PyQGIS Programmer's Guide: Extending QGIS 3 with Python 3. Locate Press. 252 p. 2018. ISBN: 9780998547725
* Menke, K.: Discover QGIS 3.x: A Workbook for Classroom or Independent Study. Locate Press. 406 p. 2019. ISBN: 9780998547763

Ajánlott irodalom

* Farkas G.: Practical GIS. Packt Publishing. 272 p. 2017. ISBN: 9781787123328
* Petrasova, A., Harmon, B., Petras, V., Tabrizian, V., Mitasova, H.: Tangible Modeling with Open Source GIS. Springer. 202 p. 2018, ISBN: 9783319893020

**Tárgy neve: Vector-based GIS (ArcGIS)**

Tárgyfelelős neve: Dr Pál Márton

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Confidence in the use of vector-based geospatial software

- Knowledge of the basic concepts of vector spatial information systems

- Knowledge to produce thematic maps to meet all needs

b, abilities

- Ability to interpret complex professional problems in the field of geoinformatics, to explore the necessary theoretical and practical background and to solve problems.

- Ability to interpret geographical/spatial phenomena, processes and information, and to plan, organize, manage and control processes in the field of geoinformatics.

c, attitude

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Committed to adhering to and making others adhere to quality requirements

- Monitors professional and technological developments in the field of geoinformatics and the labour market trends.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma: The purpose of the course is to present the basic tools and applications of vector GIS using the possibilities of ArcGIS software. The course teaches the students through the most important steps of GIS projects. After learning about data sources and formats, they learn how to manage map layers, the basics of georeferencing and digitalization. They get acquainted with the concepts of geodatabase, attribute table, subtype, domain, topology, join, spatial join, relate. Using SQL, they master the capabilities of attribute data analysis, and use the ArcGIS toolbar to perform spatial analysis. Finally, they learn how to create printable or even web-based maps based on the results.

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* Roger Tomlinson: Thinking about GIS. ESRI Press, Redlands, USA, 2007 ISBN: 9781589483484
* <https://learn-arcgis-learngis.hub.arcgis.com/>

Ajánlott irodalom:

* Michael Law – Amy Collins: Getting to Know ArcGIS Desktop, fifth edition, (2018) pp 768. ISBN: 9781589485105
* <https://downloads.esri.com/LearnArcGIS/pdf/instructional-guide-for-the-arcgis-book-2e.pdf>

**Tárgy neve: Application of ArcGIS-based Server and Web GIS**

Tárgyfelelős neve: Dr. Pál Márton

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Understand the basics of server and web GIS and their potential for presenting and sharing geographical processes and spatial data

b, abilities

- Familiar with the Esri group of products for server and web GIS, while being able to integrate products and services from other software

- Ability to build a database from spatial data and then share the data according to different needs, making it editable by specific groups or by anyone

- Ability to create different mapping applications that provide data collection, data management, geovisualisation for any discipline dealing with spatial data

c, attitude

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Committed to adhering to and making others adhere to quality requirements

- Monitors professional and technological developments in the field of geoinformatics and the labour market trends.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma: The aim of the course is to teach our students the basics of server and web GIS through ArcGIS Server Software. In a complex desktop-server-web architecture, the students have the opportunity to learn a complete GIS workflow from the building of the database to making web mapping applications. They build a GIS database from their own data, then they publish the data through various services. Finally, they create their own map application. Through this process, they will get familiar with other ESRI software (Portal, Online), and they will learn to integrate other services into the system (WMS, WMTS).

A számonkérés és értékelés rendszere: practical course mark based on course work

Kötelező irodalom:

* Di Martino, Sergio & Peron, Adriano & Tezuka, Taro. (2013). Web and Wireless Geographic Information Systems. Journal of Spatial Information Science. 6. 10.5311/JOSIS.2013.6.145.
* Roger Tomlinson: Thinking about GIS. ESRI Press, Redlands, USA, 2007 ISBN: 9781589483484
* <https://learn-arcgis-learngis.hub.arcgis.com/>

Ajánlott irodalom:

* Keller, G. Randy (1946-) (szerk.), Baru, Chaitanya (szerk.): Geoinformatics: cyberinfrastructure for the solid Earth sciences. Cambridge, Cambridge University Press, 2011 ISBN: 9780521897150
* N.M. Naidu: Geoinformatics and geostatistics. New Delhi, SBS Publishers & Distributors, 2009 ISBN: 9788189741983
* Peterson, Michael. (2017). Advances in Cartography and GIScience: Selections from the International Cartographic Conference 2017. 10.1007/978-3-319-57336-6.
* Sample, John & Ioup, Elias. (2010). Tile-Based Geospatial Information Systems. 10.1007/978-1-4419-7631-4.

**Tárgy neve: High Resolution Remote Sensing L**

Tárgyfelelős neve: Dr. Jung András

Tárgyfelelős tudományos fokozata: habil. PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Comprehensive knowledge of the problem-solving principles, methodology and processes of the planning, development and operation processes of the geoinformatics field, especially in the following areas: database management, Big Data data-mining, primary and secondary data collection, Earth observation, spatial and temporal data analysis, modelling and simulation of processes, network analysis, 3-dimensional modelling, geovisualization, geostatistical solutions, web-based geoinformatics services, spatial services development, geoinformatics programming, development of geospatial applications, open-source geoinformatics.

- Knowledge of the specific tools of geoinformatics, ability to apply field survey procedures, data management and analysis, and visualization solutions. Knowledge and use of spatial data collection technologies, available databases and spatial information software, as well as open-source and commercial geoinformatics software, cloud-based geoinformatics solutions.

- Understandings, knowledge and application of mobile field, laboratory and practical materials, tools and methods of geoinformatics.

b, abilities

- Ability to collect data independently and organize spatial data into a database, as well as to organize the data with the tools of geoinformatics. Ability to perform operations and models with independently organized databases.

- Ability to creatively and methodically process, evaluate, interpret and analyse measurement results and draw conclusions from them.

- Ability to recognize and apply new problem-solving methods and procedures in his/her field and apply what he/she has learnt in a diverse, multidisciplinary environment.

c, attitude

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Open to professional cooperation with professionals working in related fields.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma: This course introduces the principles, the methods and the techniques of high-resolution remote sensing. The imaging and non-imaging optical data acquisition workflow will be discussed with special attention to multi- and hyperspectral measurements. Different platforms (handheld, UAV, airborne, underwater, etc.) will be shown with their application areas. The theory and application of field spectroscopy will be discussed in detail, even its importance in proximal and satellite remote sensing. An overview will be given about active and passive high resolution remote sensing systems in a multidisciplinary context. The state-of-the-art of science and technology in a domestic and international approach will be presented, while highlighting the future developments. Special attention will be given to new scientific results, industrial applications and comparative studies. After completing this course, the students will be able to select and apply high resolution remote sensing techniques and methods to support their own scientific work, research and geospatial evolvement.

A számonkérés és értékelés rendszere: oral and/or written exam.

Kötelező irodalom:

* He, Yuhong, and Qihao Weng, eds. (2018) High spatial resolution remote sensing: data, analysis, and applications. CRC press, ISBN 9780429470196
* Thenkabail, Prasad S., and John G. Lyon, eds. (2016) Hyperspectral remote sensing of vegetation. CRC press, ISBN 9781138066250
* McCoy, Roger M. (2005) Field methods in remote sensing. Guilford Press, ISBN 1-59385-080-8

Ajánlott irodalom:

* Vohland, M. and Jung, A. (Eds). (2021) Hyperspectral Imaging for Fine to Medium Scale Applications in Environmental Sciences. MDPI, ISBN 978-3-0365-0878-8
* Toro, F. G., Tsourdos, A. (Eds.). (2018) UAV sensors for environmental monitoring. MDPI Publishing. MDPI, ISBN 978-3-03842-754-4
* Gonzalez, F. and Tsourdos, A. (Eds) (2018) UAV or Drones for Remote Sensing Applications (Volume 1). MDPI, ISBN 978-3-03897-092-7

**Tárgy neve: High resolution remote sensing P**

Tárgyfelelős neve: Dr. Jung András

Tárgyfelelős tudományos fokozata: habil. PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Comprehensive knowledge of the problem-solving principles, methodology and procedures of the planning, development and operation processes of the geoinformatics field, especially in the following areas: database management, Big Data - data mining, primary and secondary data collection, earth observation, spatial and temporal data analysis, processes modelling and simulation, network analysis, 3-dimensional modelling, geovisualization, geostatistical solutions, web geoinformatics services, development of spatial services, geoinformatics programming, development of GIS applications, open-source GIS.

- Has knowledge of the specific tools of the geoinformatics field, is able to apply field survey procedures, data management and analysis, and representation solutions. Knows and uses spatial data collection technologies, available databases and GIS software, as well as open-source and commercial geoinformatics software, cloud-based geoinformatics solutions.

- Understand, know and apply the mobile field, laboratory and practical possibilities, tools and methods of remote sensing.

b, abilities

- Ability to creatively and systematically process, evaluate, interpret, analyse and draw conclusions from measurement results.

- Ability to collect data independently and organize spatial data into a database, as well as to organize the data with the tools of geoinformatics. Able to perform operations and model with independently organized databases.

- Is able to recognize and apply new problem-solving methods and procedures in his / her field and apply what he / she has learned in a diverse, multidisciplinary environment.

c, attitude

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Open to professional cooperation with professionals working in related fields.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma: During the internships, students will learn the basics, tools, and methods of near-ground remote sensing. With the related software and hardware infrastructure. They perform imaging and non-imaging optical data collection in the form of independent measurements, master multispectral and hyperspectral measurement techniques, learn about the application possibilities of different platforms (ASD FieldSpec, QMini, UHD185, multicopter, Flir, etc.). The exercises provide a detailed insight into the data collection process of field spectroscopy and its role in the field of ground-truthing. We review in detail the near-earth device system and multidisciplinary position of high-resolution active and passive remote sensing. We deal separately with industrial applications and their scientifically demanding approach. Using statistical and image processing software, students evaluate their measurement results and their usability. After completing the exercises, the student will be able to assemble the hardware, software and method elements necessary for his / her independent scientific work.

The emergence of artificial intelligence in the processing of remotely sensed data: machine learning algorithms (e.g., Random Forest, Support Vector Machine) and deep learning algorithms (e.g., CNN – Convolutional Neural Network) in image processing, primarily using open-source software tools

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* Vohland, M., A. Jung, eds. (2020) Hyperspectral Imaging for Fine to Medium Scale Applications in Environmental Sciences. Remote Sens. 12(18), 2962; <https://doi.org/10.3390/rs12182962>
* pdf materials published by the instructor on ELTE-CANVAS system

Ajánlott irodalom:

* Rossel, R. A. V., McBratney, A. B., Minasny, B. (Eds.). (2010) Proximal soil sensing. Springer Science & Business Media. ISBN 978-90-481-8859-8
* McCoy, Roger M. (2005) Field methods in remote sensing. Guilford Press, ISBN 9781593850791

**Tárgy neve: Scripting languages in webcartography**

**Tárgyfelelős neve**: Dr. Gede Mátyás

**Tárgyfelelős tudományos fokozata**: PhD, habil.

**Tárgyfelelős MAB szerinti akkreditációs státusza**: AT

**Purpose of education:**

**a) knowledge**

 - Comprehensive knowledge of the principles, methods and procedures for the design, development and operation of geoinformatics, in particular in the following areas: operating systems and database management, design and development of web-based geoinformatics tools and services, geoinformatics-related programming principles, geospatial application development.

 -Knowledge of the specific tools of the field of cartography and geoinformatics, the mathematical and cartographic principles of editing maps for different purposes, the ability to apply survey procedures, representational solutions and various reproduction technologies.

 - Ability to create maps and geoinformatics systems that can be used by economic sectors or clients in the desired field.

**b) abilities**

 - Ability to interpret and formalise complex professional problems in the field of cartography and geoinformatics, to identify the necessary theoretical and practical background and to solve the problem. Ability to provide consultancy, problem-solving, design, development, operation and management of cartographic and geoinformatics systems, decision support systems and expert systems.

 - Ability to interpret, plan, organise, manage and control processes in the field of cartography and geoinformatics.

- Ability to learn and apply new problem-solving methods and procedures in the field.

**c) attitude**

- It monitors professional and technological developments in the field of cartography and geoinformatics and the opportunities that will enable it to work in the public sector, in various companies or to set up and run its own business.

- Shares his/her own knowledge and values the dissemination of professional results in cartography and geoinformatics.

- It is committed to meeting and enforcing quality standards (accuracy, commitment).

 **d) autonomy and responsibility**

 - Able to work independently in IT, carrying out tasks, thinking through and developing technical issues in a self-directed manner and at a pace.

 - Responsible for meeting and enforcing deadlines. Assumes responsibility for his/her own work and that of his/her colleagues working under his/her direction and with him/her (in a project).

 - In the case of mission-critical mapping and geoinformatics systems, may be given development and operational responsibility appropriate with his/her professional competences.

**Content of education:**

Building web mapping applications based on JavaScript and Leaflet. A taste of other web mapping techniques:

- JavaScript basics

- Webmaps based on Leaflet.js

- Web virtual globe using Cesium

- SVG to HTML integration

- HTML Canvas

- X3DOM - Web rendering of 3D models

**Evaluation system**: practical course mark based on course work.

**Literature:**

**Obligatory:**

* **HTML Specification:** [**https://html.spec.whatwg.org/multipage/**](https://html.spec.whatwg.org/multipage/)
* **PHP Manual:** [**https://www.php.net/manual/en/index.php**](https://www.php.net/manual/en/index.php)

**Recommended:**

* Lecture notes written by the teacher
* JavaScript Reference: [<http://www.java2s.com/Code/JavaScriptReference/CatalogJavaScriptReference.htm>](http://www.java2s.com/Code/JavaScriptReference/CatalogJavaScriptReference.htm)

**Tárgy neve: Project management in geoinformatics**

Tárgyfelelős neve: Dr. Jung András

Tárgyfelelős tudományos fokozata: habil. PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Basic management and leadership skills to perform tasks related to the profession.

- Knowledge of the possibilities, principles and problems of the application of geoinformatics for state (e-government) and market purposes.

b, abilities

- Ability to manage processes and projects related to the field of geoinformatics at managerial level.

- Ability to perform problem solving, planning, development, operation, management and consulting tasks in the operation of geoinformatics systems, decision support systems and expert systems. Ability to work with decision makers.

- Ability to assess the business, market and innovative value of the planned and implemented geoinformatics systems, as well as their compliance with user and social needs.

c, attitude

- Open and committed to critical feedback and evaluation based on self-assessment.

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Open to professional cooperation with professionals working in related fields.

d, autonomy and responsibility

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

Az oktatás tartalma:

The aim of the course is to train students to be able to oversee their work environment, to be able to work in group on projects, and possibly lead these groups.

First, we clarify the concept of the project and the important elements that accompany the project (project rectangle). Understanding the role of a project can be attributed to a deeper examination of the project as well as a detailed study of the project life cycles (Preparation, Start-up, Planning, Follow-up, Closing, Project Afterlife). We focus on the project planning phase (network planning, time analysis, resource scheduling). Among the project management methodologies, agile methods that are best fitting current industry needs are discussed in details. General project management issues such as:

* What makes a team effective?
* Based on personality models, how can we optimize communication, collaboration, conflict management, and motivation between team members?
* What makes a good leader?
* How to prevent burnout?

are also discussed.

We also examine the project in its broader context, we provide an insight into the issue of corporate culture, analyse the advantages and disadvantages of organizational models and the optimal choice. Given the prevalence of customer service, we deal separately with the method of providing high quality customer service.

A számonkérés és értékelés rendszere: oral and/or written exam.

Kötelező irodalom:

* A Guide to the Project Management Body of Knowledge: PMBOK Guide Author: Project Man-agement Institute Publisher: Project Management Institute Year Published: 2013 Edition: 5 th ISBN: 9781935589679
* Practice Guide (Project Management Institute, 2017, ISBN: 9781628253825)

Ajánlott irodalom:

* Scott Berkun: The Art of Project Management. O’Really. ISBN: 978-1600330537
* A Guide to the Project Management Body of Knowledge (PMBOK® Guide) — Sixth Edition and Agile

**Obligatory optional courses – Module A**

**Tárgy neve: Automatizing spatial analysis**

Tárgyfelelős neve: Szalkai Gábor

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a) knowledge:

- Complex knowledge of the general geographical, cartographic, planning, mathematical and informatic principles, rules, relationships required for the practice of geoinformatics, especially in the following topics: geographical and spatial data collection at various scales; use of cartographic processes; knowledge of geographical and spatial processes; collection, editing and analysis of spatial data; remote sensing, photogrammetry, geostatistics, modelling, visualization, and geoinformatics system building

- Knowledge of the current theories, models and literature of geoinformatics based on scientific results. He/she is aware of the possible development directions and limits of the field of geoinformatics.

- Comprehensive knowledge and understanding of the key relationships and concepts in the field of geoinformatics, in particular in the following areas: geolocation data collection technologies, 2- and 3-dimensional geoinformatics modelling, geovisualization, spatial data infrastructures, geoinformatics programming and application development, vector and raster geoinformatics, digital image processing, web-based geoinformatics solutions, geoinformatics databases, applied geoinformatics systems.

b, abilities

- Ability to interpret geographical/spatial phenomena, processes and information, and to plan, organize, manage and control processes in the field of geoinformatics.

- Ability to interpret complex professional problems in the field of geoinformatics, to explore the necessary theoretical and practical background and to solve problems.

- Ability to collect data independently and organize spatial data into a database, as well as to organize the data with the tools of geoinformatics. Ability to perform operations and models with independently organized databases.

c, attitude

- Committed to environmentally conscious behaviour in his/her field and laboratory activities.

- Monitors professional and technological developments in the field of geoinformatics and the labour market trends.

- Committed to adhering to and making others adhere to quality requirements.

- Shares his/her knowledge, considers it important to communicate the results of geoinformatics.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

Az oktatás tartalma: The aim of the course is to learn how to use the VBA interface and programming language behind Excel so that the student will be able to automate the transformation of data tables in spatial analysis and to easily perform tasks that are difficult to perform in the normal menu system.

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* Steven Roman: Writing Excel Macros with VBA, 2nd Edition, O’Reilly 2002 ISBN: 9780596003593
* <https://www.tutorialspoint.com/vba/vba_quick_guide.htm>
* <https://docs.microsoft.com/en-us/office/vba/api/overview/>

Ajánlott irodalom:

* Automating GIS-processes, <https://automating-gis-processes.github.io/site/>
* Bill Jelen, Tracy Syrstad: Microsoft Excel 2019 VBA and Macros, 2018, Book 978-1-5093-0611-4
* Michael Alexander, John Walkenbach: Excel VBA Programming for Dummies, 2018, ISBN 1119077397

**Tárgy neve: GIS in R**

Tárgyfelelős neve: Dr. Bede-Fazekas Ákos

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AR

Az oktatás célja:

a, knowledge

- Comprehensive knowledge of the problem-solving principles, methodology and processes of the planning, development and operation processes of the geoinformatics field, especially in the following areas: database management, Big Data data-mining, primary and secondary data collection, Earth observation, spatial and temporal data analysis, modelling and simulation of processes, network analysis, 3-dimensional modelling, geovisualization, geostatistical solutions, web-based geoinformatics services, spatial services development, geoinformatics programming, development of geospatial applications, open source geoinformatics.

- Knowledge of the specific tools of geoinformatics, ability to apply field survey procedures, data management and analysis, and visualization solutions. Knowledge and use of spatial data collection technologies, available databases and spatial information software, as well as open source and commercial geoinformatics software, cloud-based geoinformatics solutions.

b, abilities

- Ability to interpret complex professional problems in the field of geoinformatics, to explore the necessary theoretical and practical background and to solve problems.

- Ability to interpret geographical/spatial phenomena, processes and information, and to plan, organize, manage and control processes in the field of geoinformatics.

- Ability to creatively and methodically process, evaluate, interpret and analyse measurement results and draw conclusions from them.

c, attitude

- Monitors professional and technological developments in the field of geoinformatics and the labour market trends.

- Committed to adhering to and making others adhere to quality requirements.

- Committed to environmentally conscious behaviour in his/her field and laboratory activities.

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma: The aim of this course is to briefly introduce students to the basics of R programming language and then describe the ability of R, the software widely used by researchers and statisticians to help the work of geographers, cartographers and GIS specialist. During the course, the following four main topics are concerned: (1) GIS data management (raster/vector databases, cooperation with other geospatial software); (2) solving GIS tasks (geometric operations, transformations, interpolations); (3) visualization of geospatial data (map display, additional map symbols, base maps, interactive maps); (4) calculation with spatial descriptive statistics.

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* W. N. Venables, D. M. Smith, R Core Team: An introduction to R. <https://cran.r-project.org/doc/manuals/r-release/R-intro.pdf>
* Roger S. Bivand, Edzer J. Pebesma, Virgilio Gómez-Rubio: Applied Spatial Data Analysis with R. <http://gis.humboldt.edu/OLM/r/Spatial%20Analysis%20With%20R.pdf>

Ajánlott irodalom:

* Barry Rowlingson: Geospatial Data in R And Beyond! www.maths.lancs.ac.uk/~rowlings/Teaching/UseR2012/static/talk1.pdf
* Francisco Rodriguez-Sanchez: Spatial data in R: Using R as a GIS. <http://pakillo.github.io/R-GIS-tutorial/>
* Robin Lovelace, James Cheshire, Rachel Oldroyd és mtsai.: Introduction to visualising spatial data in R. cran.r-project.org/doc/contrib/intro-spatial-rl.pdf

**Tárgy neve: The applications of GIS in physical geography**

Tárgyfelelős neve: Dr. Telbisz Tamás

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Knowledge of the specific tools of geoinformatics, ability to apply field survey procedures, data management and analysis, and visualization solutions. Knowledge and use of spatial data collection technologies, available databases and spatial information software, as well as open source and commercial geoinformatics software, cloud-based geoinformatics solutions.

- Understandings, knowledge and application of mobile field, laboratory and practical materials, tools and methods of geoinformatics.

- In his/her native language, he/she confidently uses the conceptual system and terminology describing natural processes and can adapt it to the conceptual framework of geoinformatics.

b, abilities

- Ability to interpret complex professional problems in the field of geoinformatics, to explore the necessary theoretical and practical background and to solve problems.

- Ability to understand, plan and implement a quality management system for project-level tasks in the field of geoinformatics.

- Ability to collect data independently and organize spatial data into a database, as well as to organize the data with the tools of geoinformatics. Ability to perform operations and models with independently organized databases.

c, attitude

- Monitors professional and technological developments in the field of geoinformatics and the labour market trends.

- Committed to adhering to and making others adhere to quality requirements.

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma:

Introduction into theory and practice of project-based physical geographical research using Geoinformatics (GIS) is the principal goal of this course. The aim of this practical course is to use routines of handling and analysing digital elevation models and geostatistics obtained previously in order to solve problems that are in the focus of physical geographical studies. Consequently, the course allows to recognize the opportunities and limitations of GIS-based analyses in classical physical geographical and geomorphological research. Students could gain practice in managing research projects including finding out relevant research questions, using effective research methodology and analysing/publishing data and results due to the project-based learning and workflow.

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* Otto, J.C., Prasicek, G., Blöthe, J. and Schrott, L., 2018: GIS applications in geomorphology. In: Comprehensive Geographic Information Systems; Huang, B., Ed.; Elsevier Inc.: Bonn, Germany, pp.81-111.; doi:10. 1016/B978-0-12-409548-9.10029-6
* Tarolli, P., 2014: High-resolution topography for understanding Earth surface processes: Opportunities and challenges. Geomorphology, 216, pp. 295-312. doi: <https://doi.org/10.1016/j.geomorph.2014.03.008>

Ajánlott irodalom:

* Davis, J.C. 2002: Statistics and Data Analysis in Geology, 3rd Edition. John Wiley & Sons., New York, 656 p.; ISBN: 9780471172758
* Reddy, G.P.O. 2018: Remote Sensing and GIS for Geomorphological Mapping. In: Reddy G., Singh S. (eds) Geospatial Technologies in Land Resources Mapping, Monitoring and Management. Geotechnologies and the Environment, vol 21. Springer, Cham. doi: <https://doi.org/10.1007/978-3-319-78711-4_12>

**Tárgy neve: Creating Databases in Human Geography**

Tárgyfelelős neve: Bottlik Zsolt

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a) knowledge

- Use of database management software

- Knowledge of basic database concepts

- Systematic structuring of data

b) abilities

- Understanding complex technical problems

- Interpretation of spatial phenomena

- Complex processing of results

c) attitude

- Committed to environmentally conscious behaviour in his/her field and laboratory activities.

- Committed to adhering to and making others adhere to quality requirements.

- Shares his/her knowledge, considers it important to communicate the results of geoinformatics.

- Open to professional cooperation with professionals working in related fields.

d) autonomy and responsibility

 - Independence regarding the thorough examination and elaboration of professional issues and processes.

Az oktatás tartalma: The course is based on the use of MS Access. The aim of the course is to acquaint students with the initial steps of database construction and to organize the data of a specific socio-geographical phenomenon into relations, as well as to start and further develop the construction of the database. This process will introduce students to the basic database elements (tables, queries, forms, reports) and their use. The procedures for designing the database will be mastered through the problem of sorting the data. They will also learn about methods that simplify data entry and limit errors. Algorithms that ensure the fastest possible retrieval of data information will also help them to use other GIS-based systems.

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* Alexander, M – Kusleika R. (2018): Access 2019 Bible. John Wiley and Sohn Inc, New York 1136 p.
* Ron McFadyen (2016): Relational Databases and Microsoft Access, Open Textbook, <https://open.umn.edu/opentextbooks/formats/609>
* Steven Roman (2002): Access Database, Design and Programming, O’Reilly, ISBN 978-0596002732

Ajánlott irodalom:

* McGrath, M. (2019): Access in easy steps - illustrated using Access 2019: Illustrating using Access 192 p.
* Pratt, P. – Last, M. (2016): Shelly Cashman Series Microsoft®Office 365 & Access®2016: Comprehensive, 856 p.
* Garry Robinson (2004): Real World Microsoft Access Database Protection and Security, Springer, DOI:10.1007/978-1-4302-0793-1

**Tárgy neve: CAD-based GIS**

Tárgyfelelős neve: Dr. José Jesús Reyes Nunez

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a) knowledge

- Confident in the use of vector based geospatial software

- Knowledge of the basic concepts of vector-based GIS

- Ability to produce maps to meet all requirements

- Knowledge of CAD commands

b, abilities

- Ability to interpret complex professional problems in the field of geoinformatics, to explore the necessary theoretical and practical background and to solve problems.

- Ability to interpret geographical/spatial phenomena, processes and information, and to plan, organize, manage and control processes in the field of geoinformatics.

c, attitude

 - Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

 - Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

 - Independence regarding the thorough examination and elaboration of professional issues and processes

 - Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma: The aim of the course is to learn the basics of AutoCAD software. The course topic covers the joint use of ArcGIS software too, as it is essential for GIS specialists to know the transition among these software programs. As CAD software solutions are preferred and often used in municipal GIS, the examples during the course and the practical tasks and project tasks are related to the geographical scale of settlements.

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* An Introduction to AutoCAD for Beginners. Learn about AutoCAD. Autodesk - AutoCAD. online, <https://images-na.ssl-images-amazon.com/images/I/C1BxaOC0-IS.pdf>
* The Hitchhiker's Guide to AutoCAD. Autodesk Help. online, <https://knowledge.autodesk.com/support/autocad/learn-explore/caas/CloudHelp/cloudhelp/2020/ENU/AutoCAD-Core/files/GUID-2AA12FC5-FBB2-4ABE-9024-90D41FEB1AC3-htm.html>

Ajánlott irodalom:

* Elliot J. Gindis – Robert C. Kaebisch (2021): Up and Running with AutoCAD 2021. Elsevier. ISBN 978-0-12-823117-3. DOI <https://doi.org/10.1016/C2019-0-04914-X>
* Rick Ellis – Russell Martin (2020): A Practical Guide to AutoCAD Map 3D 2020. ISBN 978-1934865460.

**Tárgy neve: Environment and GIS**

Tárgyfelelős neve: Dr. Varga Zsófia Krisztina

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Knowledge of national and international conservation categories

- Knowledge of spatial data bases used in nature conservation

- Knowledge of the vocabulary of nature conservation

- Negotiation skills in spatial data management for nature conservation projects

b, abilities

- Management of nature conservation data using geographic information software

- Active participation in the preparation of conservation project plans

- Competence in dealing with domestic nature conservation problems

c, attitude

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Committed to environmentally conscious behaviour in his/her field and laboratory activities.

- Monitors professional and technological developments in the field of geoinformatics and the labour market trends.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

Az oktatás tartalma: The aim of the course is to introduce students to the basic issues of nature conservation (species-level protection, habitat protection, population protection) and to give a brief overview of national and international nature conservation classification systems. After that, students study GIS challenges facing nature conservation, gain insight into the GIS databases of nature conservation, conduct landscape character surveys in a freely chosen sample area, get acquainted with the GIS database of NATURA 2000 sites, use realistic ecosystems. A practical task relating to the protection of wetlands in the Carpathian Basin will be solved by creating a map database of present and past wetlands and determining restoration potentials. At the end of the course, the effects of invasive species on the ecosystems are introduced and the history of the spread of an invasive species is depicted through GIS databases using some examples.

Course structure:

1. History of nature conservation (domestic, international), basic concepts (Relationship between nature conservation and environmental protection, Objects and levels of nature conservation, domestic protection categories, Forms of nature conservation activity)

2-3. GIS challenges before nature conservation: practical examples

4-5. Landscape character studies in GIS, project task

6-7. GIS system of the Natura 2000 network, project task

8. National Ecosystem Service Mapping and Assessment Program (NÖSZTÉP)

9-10. Land cover - ecosystem - ecosystem service, project task

11-12. Extent of loss and restoration potential of wetlands in the Carpathian Basin by joint evaluation of soil, surface cover and habitat maps using GIS methods (based on Decleer et al 2016), project task

13. Invasive (alien) species and conservation issues. Use of major Hungarian invasive animal and plant species, nature conservation treatments, Hungarian national parks, <http://web.okir.hu/sse/?group=TIR> OKIR.

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* Haines, Aubrey (1996). The Yellowstone Story: A History of Our First National Park: Volume 1 Revised Edition. Yellowstone Association for Natural Science, History of Education.
* Primack, B.R. (2014): Essentials of Conservation Biology, Sixth Edition. Boston University
* Dyke, F. (2003) Conservation Biology: Foundations, Concepts, Applications

Ajánlott irodalom:

* Harvey, F; Mei-Po Kwan; Pavlovskaya M (2005): Introduction: Critical GIS, Cartographica,

Volume 40 Issue 4, Winter, DOI: 10.3138/04L6-2314-6068-43V6

* ESRI (2007): GIS for Wildlife Conservation, <https://www.esri.com/~/media/Files/Pdfs/library/bestpractices/wildlife-conservation.pdf>
* Geneletti, D (2004): A GIS-based decision support system to identify nature conservation priorities in an alpine valley, Land Use Policy, Volume 21, Issue 2

**Tárgy neve: Spatial energy planning**

Tárgyfelelős neve: Dr. Varga Zsófia Krisztina

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Knowledge of the specific tools of geoinformatics, ability to apply field survey procedures, data management and analysis, and visualization solutions. Knowledge and use of spatial data collection technologies, available databases and spatial information software, as well as open source and commercial geoinformatics software, cloud-based geoinformatics solutions.

- Understandings, knowledge and application of mobile field, laboratory and practical materials, tools and methods of geoinformatics.

- Knowledge in the main characteristics of renewable energy sources, the operating principles of the technologies that use them and the spatial representation of their main technical characteristics.

- Understands the principles and interrelationships of sustainable energy systems and is able to place technologies in the modern energy system due to wide perspective

b, abilities

- Ability to interpret complex professional problems in the field of geoinformatics, to explore the necessary theoretical and practical background and to solve problems.

- Ability to recognize and apply new problem-solving methods and procedures in his/her field and apply what he/she has learnt in a diverse, multidisciplinary environment.

- Ability to collect data independently and organize spatial data into a database, as well as to organize the data with the tools of geoinformatics. Ability to perform operations and models with independently organized databases

c, attitude

- Committed to environmentally conscious behaviour in his/her field and laboratory activities.

- Monitors professional and technological developments in the field of geoinformatics and the labour market trends.

- Committed to adhering to and making others adhere to quality requirements.

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects

Az oktatás tartalma: The purpose of this subject is to analyse the energy technologies described by the instructor on a project-based basis and to learn how to solve problems with geospatial support. Its main components are:

Section 1:

Energy systems (local, regional, national), trends, main development directions;

Characteristics of renewable energy sources and energy conversion technologies, their relationship to geographical space;

Case studies on the relationship between energy and GIS;

Environmental and energy-related (spatial) databases;

Section 2:

Geo-database construction, data management;

Spatial optimization of resources, site selection;

Modelling, production of statements: energy balances, geostatistics

Section 3:

Project work: self-employment with the chosen technology/plot, with the possibility of consultation;

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* Bent Sørensen: Renewable Energy. Physics, Engineering, Environmental Impacts, Economics and Planning. Academic Press. 1056 p. 2017 ISBN: 9780128026106
* Stoeglehner, G. (2020). Integrated spatial and energy planning: a means to reach sustainable development goals. Evolutionary and Institutional Economics Review. doi:10.1007/s40844-020-00160-7

Ajánlott irodalom:

Publications from the following journals:

* Renewable and Sustainable Energy Reviews;
* International Journal of Energy Planning and Management;
* Journal of Cleaner Production;

**Tárgy neve: Google Earth Engine**

Tárgyfelelős neve: Dr. Bede-Fazekas Ákos

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AR

Az oktatás célja:

a, knowledge

- Using previously acquired knowledge and experience, a high level of proficiency in almost any geographic information software and the ability to transfer this to others.

- Practical use of GIS in a wide range of subjects

- Producing user manuals

b, abilities

- Ability to interpret complex professional problems in the field of geoinformatics, to explore the necessary theoretical and practical background and to solve problems.

- Ability to interpret geographical/spatial phenomena, processes and information, and to plan, organize, manage and control processes in the field of geoinformatics.

c, attitude

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Committed to adhering to and making others adhere to quality requirements

- Committed to environmentally conscious behaviour in his/her field and laboratory activities.

- Monitors professional and technological developments in the field of geoinformatics and the labour market trends.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma: The aim of the course is to familiarize the students with software products that were made for special purposes. Each student chooses a software program, they learn its use, then they make a short description about it, and show its use to other students via examples.

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* Roger Tomlinson: Thinking about GIS. ESRI Press, Redlands, USA, 2007 ISBN: 9781589483484
* <https://www.researchgate.net/publication/323945547_Fundamentals_of_GIS>

Ajánlott irodalom:

* <https://www.researchgate.net/publication/331566663_Introduction_to_SAGA_GIS>
* <https://www.hec.usace.army.mil/software/hec-ras/documentation/HEC-RAS%205.0%20Reference%20Manual.pdf>

**Tárgy neve: Hydrologic modelling**

Tárgyfelelős neve: Dr. Telbisz Tamás

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Complex knowledge of the general geographical, cartographic, planning, mathematical and informatic principles, rules, relationships required for the practice of geoinformatics, especially in the following topics: geographical and spatial data collection at various scales; use of cartographic processes; knowledge of geographical and spatial processes; collection, editing and analysis of spatial data; modelling

- Knowledge of the current theories, models and literature of geoinformatics based on scientific results. He/she is aware of the possible development directions and limits of the field of geoinformatics.

b, abilities

- Ability to interpret complex professional problems in the field of geoinformatics, to explore the necessary theoretical and practical background and to solve problems.

- Ability to creatively and methodically process, evaluate, interpret and analyse measurement results and draw conclusions from them.

- Ability to use the professional vocabulary of geoinformatics in his/her mother tongue and English.

c, attitude

- Committed to environmentally conscious behaviour in his/her field and laboratory activities.

- Monitors professional and technological developments in the field of geoinformatics and the labour market trends.

- Committed to adhering to and making others adhere to quality requirements.

- Open and committed to critical feedback and evaluation based on self-assessment.

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma:

Hydrological data types (precipitation, infiltration evapotranspiration, runoff).
 Types and aims of hydrological models.
 Drainage network derivation from DTMs.
 Calculation of drainage basin characteristics.
 Simple rainfall-runoff model creation using DTM.
 Project work.

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* Li Z, Zhu C, Gold C, 2005: Digital Terrain Modeling. Principles and Methodology. CRC Press, 340 p., ISBN 9780415324625.
* Rabus, B., Eineder, M., Roth, A., Bamler, R. (2003): The shuttle radar topography mission – a new class of digital elevation models acquired by spaceborne radar. ISPRS Journal of Photogrammetry and Remote Sensing, 57(4):241-262.
* O'Callaghan, J.F., Mark, D.M., 1984: The extraction of drainage networks from digital elevation data. – Computer Vision, Graphics and Image Processing, 28, 323–344.

Ajánlott irodalom:

* Freeman, T.G., 1991: Calculating catchment are with divergent flow based on a regular grid. – Computers and Geosciences, 17(3), 413–422.
* Kiss, R. Determination of drainage network in digital elevation models, utilities and limitations. Journal of Hungarian Geomathematics, 2, 16-29., 2004
* Moore, I.D., Grayson, R.B., Ladson, A.R., 1991: Digital terrain modelling: A review of hydrological, geomorphological, and biological applications. – Hydrological Processes. 5(1), 3–30.
* Burrough, P.A. – McDonnell, R.A: Principles of Geographical Information Systems. – Oxford University Press, Oxford, 306 p., 1998 ISBN: 9780198742845
* Tarboton, D.G., 1997: A New Method for the Determination of Flow Directions and Contributing Areas in Grid Digital Elevation Models. – Water Resources Research, 33(2), 309–319.

**Tárgy neve: Nature conservation and GIS**

Tárgyfelelős neve: Dr. Jakab Gusztáv

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Knowledge of national and international nature conservation categories

- Knowledge of spatial databases used in nature conservation

- Knowledge of nature conservation vocabulary

- Has negotiation skills in spatial data management for conservation projects

b) abilities

- Management of nature conservation data using geographic information software

- Active participation in the preparation of conservation project plans

- Competence in dealing with domestic nature conservation problems

c, attitude

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Committed to environmentally conscious behaviour in his/her field and laboratory activities.

- Monitors professional and technological developments in the field of geoinformatics and the labour market trends.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

Az oktatás tartalma:

The aim of the course is to introduce students to the basic issues of nature conservation (species-level protection, habitat protection, population protection) and to give a brief overview of national and international nature conservation classification systems. After that, students study GIS challenges facing nature conservation, gain insight into the GIS databases of nature conservation, conduct landscape character surveys in a freely chosen sample area, get acquainted with the GIS database of NATURA 2000 sites, use realistic ecosystems. In relation to the protection of wetlands in the Carpathian Basin, a practical task will be solved by creating a map database of present and past wetlands and determining restoration potentials. At the end of the course, the effects of invasive species on the ecosystems are introduced and the history of the spread of an invasive species is depicted through GIS databases using some examples.

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* Haines, Aubrey (1996). The Yellowstone Story: A History of Our First National Park: Volume 1 Revised Edition. Yellowstone Association for Natural Science, History of Education.
* Primack, B.R. (2014): Essentials of Conservation Biology, Sixth Edition. Boston University
* Dyke, F. (2003) Conservation Biology: Foundations, Concepts, Applications

Ajánlott irodalom:

* ed. Tom Mueller, Gretchen F. Sassenrath (2015). GIS Applications in Agriculture, Volume Four, Conservation Planning, Taylor & Francis, ISBN 9781032098807
* ed. Basil G. Savitsky and Thomas E. Lacher Jr. (1998). GIS Methodologies for Developing Conservation Strategies, Columbia University Press, ISBN 9780231100267
* Nikos Krigas, Kimon Papadimitriou and Antonios D. Mazaris (2011). GIS and ex situ Plant Conservation, IntechOpen, DOI: 10.5772/50525

**Obligatory optional courses – Module B**

**Tárgy neve: Cartographic elements in geoinformatics**

Tárgyfelelős neve: Dr. Zentai László

Tárgyfelelős tudományos fokozata: DSc

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Familiar with the general cartographic and IT principles and rules necessary for the operation of geoinformatics;

- Knowledge of the specific tools of the geoinformatics discipline, the cartographic elements of field survey procedures, data management and analysis, effective cartographic representation in a geoinformatics environment;

- Knowledge and use of spatial data collection technologies, their cartographic aspects and key elements.

b, abilities

- Ability to select the most effective cartographic tools and software to solve a given task, depending on the complexity of the task;

- Ability to systematically process, evaluate, interpret and analyse the results of measurements and to support the drawing of conclusions from these results in cartographic terms, and to visualize them in an optimal way;

- Ability with the acquired cartographic knowledge to carry out effective, user-oriented planning, development and consultancy tasks in the operation of GIS, decision support systems and expert systems.

c, attitude

- Shares his/her knowledge, considers it important to communicate the results of cartography.

- Open to professional cooperation with professionals working in related fields.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma: The main aim of this course is to deliver the basic cartographic and IT elements and knowledge for the MSc students of geoinformatics. The primary task of geoinformatics is the analysis of spatial data, decision preparation and decision support. One of the most important tools for this is the map, the cartographic representation, the optimal data visualization. For the effective application of geoinformatics tools and software, for the proper visualization of our data, it is essential that students have a thorough knowledge of cartography, which can be well applied in any software environment, in any field of geoinformatics.

The primary goal of the course is to acquire the cartographic approach, to apply the most important, most effective elements of cartography in an IT, but mainly geoinformatics environment. The course facilitates the preparation to deal with cartographic problems that arise during the design, development, implementation and operation of geoinformatics systems. We lay emphasis on the development of cartographic skills in the theoretical and scientific problems of geoinformatics, and on the preparation for scientific research.

A számonkérés és értékelés rendszere: oral and/or written exam.

Kötelező irodalom:

* Kraak, MJ–Ormeling, F.: Cartography, Visualization of Spatial Data, Fourth edition, CRC Group, 2021, 261 p., ISBN 9781138613959
* Field, K.: Cartography, ESRI Press, 2018, 576 p., ISBN: 9781589484399
* United Nations: Mapping for a Sustainable World, United Nations, 2020, DOI: <https://doi.org/10.18356/9789216040468c001>

Ajánlott irodalom:

* Del Lima, M.: Handbook of Cartography, Callisto Reference, 2015, 326 p., ISBN 1632393778
* Cynthia Brewer: Designing Better Maps, 250 p., ESRI Press, 2015, ISBN: 9781589484405
* Gretchen N. Peterson : Cartographer's Toolkit: Colors, Typography, Patterns, PetersonGIS, 2012. 184 p.; ISBN 9780615467948

**Tárgy neve: Batch processing**

Tárgyfelelős neve: Dr. Kovács Béla

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Knowledge of open- and closed-source operating systems

- Knowledge of distributed resource and supercomputing systems

- Knowledge of virtualised computing environments

- Installation and operation of linux systems

- Operation of field data collection devices

- Mobile device architecture

b, abilities

- Ability to use non MS-based operating systems (Unix, linux, android, etc.)

- Ability to install and operate open-source operating systems in real and virtualised environments

- Ability to perform basic management of cloud-based systems

- Program and operate field data collection tools

- Ability to perform basic management of computer local area networks

c, attitude

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma:

- the basics of operating systems, terms and acronyms (UNIX, linux, free, non-free, BSD, CC, etc.)- the core of UNIX-based systems

* the core of GNU/linux-based systems
* the TCP/IP networks
* UNIX/linux base commands and system programs
* virtualisation and paravirtualization techniques
* Debian/Ubuntu-based systems
* RH/CentOS-based systems
* other operating systems (Android, BSD etc.)
* create and manage the graphical UI
* mini systems, microcomputers, filed data loggers

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* Online help and manual pages of the selected operating systems (<https://man7.org/linux/man-pages/>)
* Modern Operating Systems, Andrew S. Tanenbaum and Herbert Bos, 4th edition, Pearson plc. 2015, ISBN: 978-0133591620

Ajánlott irodalom:

* UNIX Tutorial for Beginners (<http://www.ee.surrey.uk/Teaching/Unix>)
* A Practical Guide to Linux Commands, Editors, and Shell Programming, Mark G. Sobell, 3rd Edition, Pearson plc. 2012, ISBN: 978-0133085044
* UNIX and Linux System Administration Handbook, by [Evi Nemeth](https://www.amazon.com/s/ref%3Ddp_byline_sr_book_1?ie=UTF8&field-author=Evi+Nemeth&text=Evi+Nemeth&sort=relevancerank&search-alias=books), [Garth Snyder](https://www.amazon.com/s/ref%3Ddp_byline_sr_book_2?ie=UTF8&field-author=Garth+Snyder&text=Garth+Snyder&sort=relevancerank&search-alias=books), [Trent Hein](https://www.amazon.com/s/ref%3Ddp_byline_sr_book_3?ie=UTF8&field-author=Trent+Hein&text=Trent+Hein&sort=relevancerank&search-alias=books), [Ben Whaley](https://www.amazon.com/Ben-Whaley/e/B0725R4PV5/ref%3Ddp_byline_cont_book_4), [Dan Mackin](https://www.amazon.com/Dan-Mackin/e/B076FDP78H/ref%3Ddp_byline_cont_book_5), 5th Edition, Addison-Wesley Professional, 2017, ISBN: 978-0134277554

**Tárgy neve: Drones in field spectroscopy**

Tárgyfelelős neve: Dr. Jung András

Tárgyfelelős tudományos fokozata: habil. PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Comprehensive knowledge of the problem-solving principles, methodology and procedures of the planning, development and operation processes of the geoinformatics field, especially in the following areas: database management, Big Data - data mining, primary and secondary data collection, earth observation, spatial and temporal data analysis, processes modelling and simulation, network analysis, 3-dimensional modelling, geovisualization, geostatistical solutions, web geoinformatics services, development of spatial services, geoinformatics programming, development of GIS applications, open-source GIS.

- Knowledge of the specific tools of the geoinformatics field, ability to apply field survey procedures, data management and analysis, and representation solutions. Knowledge and use of spatial data collection technologies, available databases and GIS software, as well as open-source and commercial geoinformatics software, cloud-based geoinformatics solutions.

- Understanding, knowing and applying the mobile field, laboratory and practical applications, tools and methods of remote sensing.

b) abilities

- Ability to creatively and systematically process, evaluate, interpret, analyse and draw conclusions from measurement results.

- Ability to collect data independently and organize spatial data into a database, as well as to organize the data with the tools of geoinformatics. Able to perform operations and model with independently organized databases.

- Ability to recognize and apply new problem-solving methods and procedures in his/her field and apply what he/she has learned in a diverse, multidisciplinary environment.

- Ability to collect data independently and organize spatial data into a database, as well as to organize the data with the tools of geoinformatics. Ability to perform operations and models with independently organized databases.

- Ability to recognize and apply new problem-solving methods and procedures in his/her field and apply what he/she has learnt in a diverse, multidisciplinary environment.

c, attitude

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Open to professional cooperation with professionals working in related fields.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma: The declining size and the increasing performance of portable field devices and the proliferation of multicopters have had a significant impact on field data collection, documentation, and mapping. GIS specialists also perform field work, including the production, verification or qualification of measurement results. Multicopters and other rigid-wing unmanned aerial platforms will play a significant role in this data collection process. Their applicability has accelerated tremendously, and their development and spread are unstoppable. Acquiring the theoretical and practical knowledge necessary for use and application is the basic goal of the course. A part of the training is to perform independent flight exercises, to get acquainted with the data collection and processing workflows. Understanding the operation of drone sensors (thermal, multi- and hyperspectral, Lidar, etc.), mastering its application possibilities.

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* Elliott, Z.P (2019) The Drone Pilot Handbook - ISBN-13-978-1675964255
* pdf materials published by the instructor on ELTE-CANVAS system

Ajánlott irodalom:

* Calafate,C. T., Tropea, M. (Eds.) (2020) Unmanned Aerial Vehicles
 Platforms, Applications, Security and Services. MDPI Publishing. ISBN 9783039367092
* [www.easa.europe.eu](http://www.easa.europe.eu/)
* ASA Test Board (2020) Remote Pilot Test Prep 2021. ISBN13(EAN): 9781619549753

**Tárgy neve: GIS-based cartography**

Tárgyfelelős neve: Dr. Reyes Nunez José Jesús

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Comprehensive knowledge and understanding of the key relationships and concepts in the field of geoinformatics, in particular in the following areas: geolocation data collection technologies, 2- and 3-dimensional geoinformatics modelling, geovisualization, spatial data infrastructures, geoinformatics programming and application development, vector and raster geoinformatics, digital image processing, web-based geoinformatics solutions, geoinformatics databases, applied geoinformatics systems.

- Understandings, knowledge and application of mobile field, laboratory and practical materials, tools and methods of geoinformatics.

b, abilities

- Ability to creatively and methodically process, evaluate, interpret and analyse measurement results and draw conclusions from them.

- Ability to collect data independently and organize spatial data into a database, as well as to organize the data with the tools of geoinformatics. Ability to perform operations and models with independently organized databases.

- Ability to recognize and apply new problem-solving methods and procedures in his/her field and apply what he/she has learnt in a diverse, multidisciplinary environment.

c, attitude

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma: During the theoretical introduction to the course, the students become acquainted with the relation between geoinformatics and the world of general graphic software, presenting topics related to the antecedents, features, modules and applications. In the practices, students learn about the interaction of geoinformatics with drawing and editing options, importing and georeferencing GIS and graphic files, as well as preparing base maps, creating thematic maps and formatting a map sheet using a GIS module in a general graphic program. Students will be able to use topology-based drawing commands, to edit objects based on their attributes, to define attribute-based filters, to generate a nomenclature automatically and manually, and finally display the generated maps on printed and different interactive digital media (e.g. web and mobile devices).

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* Avenza (2020) MAPublisher 10.6: What’s new? Accessible on: <https://www.avenza.com/help/mapublisher/10.6/index.html?whats_new_in_mapublisher.htm>
* Dodge, M., McDerby, M. and Turner, M. John (2008) Geographic visualization: concepts, tools and applications. Wiley&Sons, Ltd. ISBN 978-0-470-51511-2

Ajánlott irodalom:

* Peterson, G. N. (2020) GIS Cartography: A Guide to Effective Map Design, Third Edition. Taylor & Francis Limited, ISBN 0367857944, 9780367857943
* Cairo, A. (2016) The truthful art: data, charts, and maps for communication. New Riders. ISBN 13: 9780321934079
* Sui, D., Elwood, S. and Goodchild, M.(2013) Crowdsourcing Geographic Knowledge (VGI in theory and practice). Springer, ISBN: 978-94-007-9826-7

**Tárgy neve: Map Projections 2**

Tárgyfelelős neve: Dr. Kerkovits Krisztián

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Complex knowledge of the general geographical, cartographic, planning, mathematical and informatic principles, rules, relationships required for the practice of geoinformatics

- Knowledge of the current theories, models and literature of geoinformatics based on scientific results. He/she is aware of the possible development directions and limits of the field of geoinformatics.

- In his/her native language, he/she confidently uses the conceptual system and terminology describing natural processes and can adapt it to the conceptual framework of geoinformatics.

b, abilities

- Ability to interpret complex professional problems in the field of geoinformatics, to explore the necessary theoretical and practical background and to solve problems.

- Ability to initiate cooperation with design and development professionals and end users of geoinformatics results.

- Ability to use the professional vocabulary of geoinformatics in his/her mother tongue and English.

c, attitude

- Monitors professional and technological developments in the field of geoinformatics and the labour market trends.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma:

* Classification of non-conical projections, selecting a map projection
* Pseudocylindrical projections: Apian I, II, sinusoidal
* Eckert projections, polyhedric, Robinson, Ginzburg VIII, loximutal
* Auxiliary latitude: Mollweide
* Wagner transform: Kavrayskiy VI, VII.
* Compound projections: Goode, Érdi-Krausz, Baranyi II, IV.
* Pseudoconic & pseudoazimuthal projections: Bonne, Ginzburg III.
* Polyconic projections: ordinary, War Office, equal-area
* Pseudopolyconic projections: Lagrange, Nicolosi, Van der Grinten I, Ginzburg IV–VII.
* Modified azimuthal projections: Aitoff, Hammer, Winkel III, Raisz, retroazimuthal
* Special projections: conformal non-conical projections, polyhedral projections
* Identification of a map projection, optimalizaton of map distortions

A számonkérés és értékelés rendszere: oral and/or written exam.

Kötelező irodalom:

* Snyder, J. P.: Map projections: A working manual U. S. Government Printing Office. Washington D.C. 397 p., 1987 ISBN: 9781782662228
* Fenna, D.: Cartographic Science: A Compendium of Map Projections, with Derivations. CRC Press. Boca Raton, FL. 504 p, 2007 ISBN: 9780849381690

Ajánlott irodalom

* Snyder, J. P.; Voxland, P. M.: An album of map projections. U. S. Government Printing Office. Washington D.C. 249 p. 1989 DOI: 10.3133/pp1453
* Grafarend, E. W., Krumm, F. W.: Map Projections: Cartographic Information Systems. Springer. Berlin. 714 p. 2006 ISBN: 9783540367024

**Tárgy neve: GIS Project**

Tárgyfelelős neve: Dr. Reyes Nunez José Jesús

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- An intensive synthesis of knowledge acquired in the previous years, covering all areas (research, programming, data presentation, drafting)

- Factual and problem-specific (detailed) knowledge of the specific task

- Knowledge of the partner institution in the case of an external data provider

b, abilities

- Independent problem-solving, decision-making on technical issues, in the field and in an office environment

- Structuring, planning and carrying out complex tasks

- Developing vocabulary and professional expression in oral and written reports

c, attitude

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma:

Students independently but driven by instructors carry out a complex task on the basis of previous studies. The tasks must contain the interpretation of problem solving of a relevant topic in GIS environment or creating and interpretation of a complex spatial information system.

Segments of the task:

• formulation of the topic and the basic questions

• data collection, digitization

• designing the database / programming

• queries

• analysis, evaluation of the results, conclusions

• development of the system and publication of the results

• documentation of the project

• oral presentation of the workflow and results

Another goal of the course is to provide a general overview of artificial intelligence, introduce key large language models, and explore auxiliary tools that support learning — including prompt engineering.

A számonkérés és értékelés rendszere**:** practical course mark based on course work.

Kötelező irodalom:

* Roger Tomlinson: Thinking about GIS. ESRI Press, Redlands, USA, 2007 ISBN: 9781589483484
* Dent, Torguson, Hodler: Cartography – Thematic Map Design. McGraw-Hill Education, 2008 ISBN: 9780697384959

Ajánlott irodalom:

* Slocum, McMaster, Kessler, Howard: Thematic Cartography and Geographic Visualization. Pearson, 2008. ISBN: 9780132298346
* Tyner, J.: Map Design. The Guilford Press, New York, 2010 ISBN: 9781462517121

**Tárgy neve: 3D modelling in geoinformatics**

Tárgyfelelős neve: Dr. Albert Gáspár

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Complex knowledge of the general geographical, cartographic, planning, mathematical and informatic principles, rules, relationships required for the practice of geoinformatics, especially in the following topics: geographical and spatial data collection at various scales; knowledge of geographical and spatial processes; collection, editing and analysis of spatial data; photogrammetry, geostatistics, modelling, visualization

- Comprehensive knowledge and understanding of the key relationships and concepts in the field of geoinformatics, in particular in the following areas: geolocation data collection technologies, 2- and 3-dimensional geoinformatics modelling, geovisualization, spatial data infrastructures, geoinformatics programming and application development, vector and raster geoinformatics

b, abilities

- Ability to interpret geographical/spatial phenomena, processes and information, and to plan, organize, manage and control processes in the field of geoinformatics.

- Ability to collect data independently and organize spatial data into a database, as well as to organize the data with the tools of geoinformatics. Ability to perform operations and models with independently organized databases.

c, attitude

- Monitors professional and technological developments in the field of geoinformatics and the labour market trends.

- Committed to environmentally conscious behaviour in his/her field and laboratory activities.

- Committed to adhering to and making others adhere to quality requirements

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma: The aim of the course is to learn about the relationship between three-dimensional modelling and geoinformatics (geodatabases, data models, etc.) and to apply the knowledge in practice. The course is practice-oriented. The focus is on the simulation of problems and tasks encountered in real geoinformatics modelling. The solution of the exercises in the classes basically emphasizes the essence of operations, which is software independent, but in the exercises we strive to use free source and easily accessible programs (e.g. SAGA). The student is expected to solve the problem with the correct result by independently constructing the modelling steps using the knowledge learned in class and prior knowledge. 3D modelling in the course means modelling phenomena that are either continuous in space or fill the space under study (e.g. temperature, air pressure, soil, rocks, contamination, groundwater, etc.).

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* Albert, G.: *3D modeling in GIS (lecture notes)*, 117 p., 2016
* Abdul-Rahman, A., & Pilouk, M. (2007). *Spatial data modelling for 3D GIS*. Springer Science & Business Media. ISBN 978-3-540-74166-4

Ajánlott irodalom:

1. El-Sheimy, N., Valeo, C., & Habib, A. (2005). *Digital terrain modeling: acquisition, manipulation, and applications*. Artech House. ISBN 978-1580-539210
2. Lee, J., & Zlatanova, S. (Eds.). (2008). *3D geo-information sciences*. Springer Science & Business Media. ISBN: 978-3-540-87394-5
3. Conrad, O., Bechtel, B., Bock, M., Dietrich, H., Fischer, E., Gerlitz, L., Wehberg, J., Wichmann, V., and Boehner, J. (2015): System for Automated Geoscientific Analyses (SAGA) v. 2.1.4. Geosci. Model Dev., 8, 1991-2007, <https://doi.org/10.5194/gmd-8-1991-2015>

**Tárgy neve: Surveying and Topography L**

Tárgyfelelős neve: Dr. Varga Zsófia

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Knowledge of the theoretical principles of positioning on the ground;

- Knowledge of the types of geodetic measurements, the best-known procedures and instruments used;

- Knowledge of the technical content of spatial data obtained by modern geodetic methods, their applicability in the process of creating map databases

b, abilities

- Ability to select the most appropriate geodetic data extraction method for the task in question, taking into account the technical and accuracy requirements of the task;

- Ability to evaluate the technical content of spatial data generated by geodetic methods and their incorporation into map databases, and to use spatial data obtained by geodetic methods.

c, attitude

- Knowledge of geodetic survey methods and tools, data acquisition technologies, helps to develop an appropriate attitude in professional cooperation with professionals working in the field of surveying

- Committed to environmentally conscious behaviour in his/her field and laboratory activities.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma:

* The student becomes acquainted with the role of geodesy in mapping/creating map databases.
* The student forms a concept about the elements and practical implementation of reference systems.
* The student gets acquainted with the basics of geolocation, types and tools of geodetic measurements and modern methods of geodetic data acquisition.
* The participant will learn the use of geodetic field surveying instruments.

A számonkérés és értékelés rendszere: Oral and/or written exam.

Kötelező irodalom:

* B. Hofmann-Wellenhof and H. Moritz: Physical Geodesy, Springer-Verlag Wien, 2005.
* Lu, Zhiping, Qu, Yunying, Qiao, Shubo: Geodesy, Introduction to Geodetic Datum and Geodetic Systems, Springer, 2014.

Wolfgang Torge, Jürgen Müller: Geodesy, Walter de Gruyter, 2012

Ajánlott irodalom:

* Günter Seeber: Satellite Geodesy, Walter de Gruyter, 2003
* Peter J.G. Teunissen, Alfred Kleusberg: GPS for Geodesy, Springer Science & Business Media, 2012

**Tárgy neve: Geovisualization**

Tárgyfelelős neve: Dr. Albert Gáspár

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Complex knowledge of the general geographical, cartographic, planning, mathematical and informatic principles, rules, relationships required for the practice of geoinformatics, especially in the following topics: use of cartographic processes, visualization

- Knowledge of the current theories, models and literature of geoinformatics based on scientific results. He/she is aware of the possible development directions and limits of the field of geoinformatics.

- Comprehensive knowledge of the problem-solving principles, methodology and processes of the planning, development and operation processes of the geoinformatics field, especially in the following areas: geovisualization

- Knowledge of the basic processes of vision, brain imaging, spatial orientation and navigation

- Knowledge and use of experimental tools and methods for testing the usability of geovisualisation interfaces

b, abilities

- Ability to interpret complex professional problems in the field of geoinformatics, to explore the necessary theoretical and practical background and to solve problems.

- Ability to creatively and methodically process, evaluate, interpret and analyse measurement results and draw conclusions from them.

- Ability to recognize and apply new problem-solving methods and procedures in his/her field and apply what he/she has learnt in a diverse, multidisciplinary environment.

c, attitude

- Open to professional cooperation with professionals working in related fields.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma: The course presents the fundamentals of human cognitive visualization as an essential part of geoinformatics technology. The effective use of geoinformation systems depends on visual interfaces, maps and other cartographic representation forms. Visualization is interpreted as a cognitive process supported by external representation. Explore human vision, brain processes of human visual imagery, the processing and pathways of spatial information. Object recognition, the functions of the hippocampus in the human memory system. Cognitive map and spatial cognition: orientation, wayfinding, navigation. Study supporting human navigation through a visual interface. Pattern recognition and the horizontal organization of the map. Visual hierarchy and directing visual attention. Map user, use and usability studies: tools, methods and research results. UI and UX research in geoinformatics: interactive and adaptive technologies.

A számonkérés és értékelés rendszere: oral and/or written exam.

Kötelező irodalom:

* Colin Ware 2011: *Information Visualization: Perception for Design. Interactive Technologies.* Wiley, New York. ISBN: 1558608192
* MacEachren, A.M. 2004: *How Maps Work: Representation, Visualization and Design.* (New York: Guilford Press. ISBN: 0898625890
* Keim, Daniel, Jörn Kohlhammer, Geoffrey Ellis, Mansmann 2010: *Mastering the Information Age. Solving Problems withVisual Analytics*. Eurographics Association, Goslar. ISBN: 9783905673777

Ajánlott irodalom:

* Bertin, Jacques 1983: *Semiology of Graphics. Diagrams, networks, maps.* Univ. of Wisconsin Press, Madison. ISBN: 9780299090609.
* Tufte, Edward 2001: *Envisioning information*. Plenum Press, Boston, ISBN: 9780961392116
* Çöltekin, A., Bleisch, S., Andrienko, G., Dykes J. (2017). Persistent Research Challenges in Geovisualization. *International Journal of Cartography* (3) 115-139.
* Griffin, A. L., White, T., Fish, C., Tomio, B., Huang, H., Sluter, C. R., … Picanço, P. (2017). Designing across Map Use Contexts: A Research Agenda. *International Journal of Cartography*, 3(sup1), 90–114.
* Török, Zsolt Győző – Török, Ágoston 2019: Cognitive Data Visualization—A New Field with a Long History. In: Klempous, Ryszard - Jan Nikodem - Péter Zoltán Baranyi (eds.): *Cognitive Infocommunications, Theory and Applications*, Springer International, ISBN: 978-3-319-95995-5

**Tárgy neve: Image processing**

Tárgyfelelős neve: Dr. Gede Mátyás

Tárgyfelelős tudományos fokozata: habil. PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Complex knowledge of the general geographical, cartographic, planning, mathematical and informatic principles, rules, relationships required for the practice of geoinformatics

- Knowledge of the current theories, models and literature of geoinformatics based on scientific results. He/she is aware of the possible development directions and limits of the field of geoinformatics.

- Knowledge in digital image processing

- Knowledge about geoinformatics programming and application development

b, abilities

- Ability to interpret complex professional problems in the field of geoinformatics, to explore the necessary theoretical and practical background and to solve problems.

- Ability to creatively and methodically process, evaluate, interpret and analyse measurement results and draw conclusions from them.

c, attitude

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma:

Digital image processing and computer vision fundamentals and its use in geoinformatics

* Introduction to OpenCV/Python
* Basic image operations: load, display, crop, save. Various image representations (RGB, HSV, grayscale, binary) and conversions between them.
* Drawing operations
* Fundamentals of convolutional filters, most common kernel types
* Edge detection, line detection
* Feature detection. Training and using HAAR Cascades
* Character and text recognition using PyTesseract
* Camera calibration, stereo image evaluation

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* Adrian Rosebrock: Practical Python and OpenCV. 2016. <https://www.pyimagesearch.com/practical-python-opencv/>
* Joseph Howse, Joe Minichino: Learning OpenCV 4 Computer Vision with Python 3. Packt, 2020. ISBN: 9781789531619

Ajánlott irodalom:

* Mokhtar Ebrahim: Python Image Processing Tutorial (Using OpenCV). <https://likegeeks.com/python-image-processing/>
* GeeksforGeeks: OpenCV Python Tutorial. <https://www.geeksforgeeks.org/opencv-python-tutorial/>

**Tárgy neve: Thematic data visualization methods L**

Tárgyfelelős neve: Dr. Albert Gáspár

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Acquire knowledge of the history of cartography

- Learn the concepts, types and characteristics of data

- Knowledge in the types and characteristics of graphical representations and the methods to construct professionally correct thematic maps

- Interpret data (and maps) and draw conclusions

b, abilities

- Develops the graphic vision

- Ability to distinguish between reliable and unreliable data sources

c, attitude

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma:

Topic and requirements of the semester. Literature and theory of thematic cartography. Cartographic generalization.

Overview of data representation techniques. Types of base maps.

History and development of thematic cartography.

Data sources, data types and their critical evaluation.

Characteristics of the field-specific thematic maps. Map types in Geosciences.

Maps of environmental, economic and social phenomena.

Thematic maps in education.

Thematic maps on special-purpose and in communication (e. g. maps in media).

Thematic atlases.

Colour theories. Maps in black and white.

Visualization of information. Relationship of graphic symbols and data representation.

Projections of thematic maps.

Thematic cartography in Geoinformatics.

Thematic maps on Internet.

Editing and processing errors on thematic maps.

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* Dent, Torguson, Hodler: Cartography – Thematic Map Design. McGraw-Hill Education, 2008 ISBN: 9780697384959
* Slocum, McMaster, Kessler, Howard: Thematic Cartography and Geographic Visualization. Pearson, 2008. ISBN: 9780132298346

Ajánlott irodalom:

* Tyner, J.: Map Design. The Guilford Press, New York, 2010 ISBN: 9781462517121
* Peterson, G. N.: GIS Cartography. A guide to effective map design. CRC Press, 2015, ISBN: 9781482220674

**Tárgy neve: Thematic data visualization methods P**

Tárgyfelelős neve: Dr. Albert Gáspár

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Acquire knowledge of the history of cartography

- Learn the concepts, types and characteristics of data

- Knowledge in the types and characteristics of graphical representations and the methods to construct professionally correct thematic maps

- Interpret data (and maps) and draw conclusions

b, abilities

- Develops the graphic vision

- Ability to distinguish between reliable and unreliable data sources

c, attitude

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma:

Students prepare different types of thematic maps from data sets provided by the instructor or they do independent research and team work, but driven by instructor, on a complex thematic topic. This task consists of searching for special data and learning the characteristics of a socio-economic or geographic field for a specified area. Students also have to prepare documentation on their work or to prepare a descriptive, technical text on the topic they work on. The aim of this course is to meet as many data formats as possible and work with the main thematic map types.

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* Roger Tomlinson: Thinking about GIS. ESRI Press, Redlands, USA, 2007 ISBN: 9781589483484
* Dent, Torguson, Hodler: Cartography – Thematic Map Design. McGraw-Hill Education, 2008 ISBN: 9780697384959

Ajánlott irodalom:

* Slocum, McMaster, Kessler, Howard: Thematic Cartography and Geographic Visualization. Pearson, 2008. ISBN: 9780132298346
* Tyner, J.: Map Design. The Guilford Press, New York, 2010 ISBN: 9781462517121
* Malloy, N. R..: Essential Modeling Techniques for Geospatial Analysis Using ArcGIS. Geospatial institute, EUREKA, 2020

**Tárgy neve: Open Source WebGIS Programming**

Tárgyfelelős neve: Dr. Gede Mátyás

Tárgyfelelős tudományos fokozata: habil. PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Complex knowledge of the general geographical, cartographic, planning, mathematical and informatic principles, rules, relationships required for the practice of geoinformatics, especially in the following topics: geovizualization, geoinformatics system engineering, programming, web geoinformatics solutions, services, open source geoinformatics

b, abilities

- Ability to understand complex technical problems, identifying the necessary theoretical and practical background and solving problems

- Ability to design value-added services

- Ability to create decision support geoinformation systems

c, attitude

- Monitors professional and technological developments in the field of geoinformatics and the labour market trends.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma:

* General structure and components of WebGIS applications
* Introduction to OpenLayers; creating a simple web map page
* Displaying rasters in OpenLayers
* Displaying vector data in OpenLayers
* Managing vector styles
* Adding interactive functions to the map
* Integrating third party geocoding and routing services
* Fundamentals of MapServer, the role and structure of a Mapfile
* Integrating OpenLayers and MapServer
* Feature classification and basic styling in MapServer
* Complex styling in MapServer
* Using queries through WMS

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* Gede Mátyás: The OpenLayers 5 API alapjai. <http://mercator.elte.hu/~saman/edu/ol5/>
* Gede Mátyás: MapServer tutorial. <http://mercator.elte.hu/~saman/edu/mapserver/>

Ajánlott irodalom:

* Thomas Gratier, Paul Spencer, Erik Hazzard: OpenLayers 3: Beginner's Guide. ISBN: 9781782162360Gábor Farkas: Mastering OpenLayers 3. ISBN: 9781785281006
* Pericles S. Nacionales, Jeff McKenna: MapServer tutorial. <https://www.mapserver.org/tutorial/>

**Tárgy neve: Development of scripts and plugins in geoinformatics software**

Tárgyfelelős neve: Dr. Gede Mátyás

Tárgyfelelős tudományos fokozata: habil. PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Knowledge of the current theories, models and literature of geoinformatics based on scientific results. He/she is aware of the possible development directions and limits of the field of geoinformatics.

- Comprehensive knowledge and understanding of the key relationships and concepts in the field of geoinformatics, in particular in the following areas: geolocation data collection technologies, 2- and 3-dimensional geoinformatics modelling, geovisualization, spatial data infrastructures, geoinformatics programming and application development, vector and raster geoinformatics, digital image processing, web-based geoinformatics solutions, geoinformatics databases, applied geoinformatics systems.

- Knowledge of the specific tools of geoinformatics, ability to apply field survey procedures, data management and analysis, and visualization solutions. Knowledge and use of spatial data collection technologies, available databases and spatial information software, as well as open-source and commercial geoinformatics software, cloud-based geoinformatics solutions.

b, abilities

- Ability to interpret complex professional problems in the field of geoinformatics, to explore the necessary theoretical and practical background and to solve problems.

- Ability to initiate cooperation with design and development professionals and end users of geoinformatics results.

- Ability to create geoinformatics systems to support and assist decision makers

c, attitude

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma:

In the first part of the semester, the students are getting familiar with the development of plugins in QGIS. In the second half of the semester, they acquire practice in the scripting of ArcGIS with Python. At the end of the semester, the students will be able to script this software while solving individual tasks. Some examples:

Scripts in QGIS: reading files, styling layers (single symbol, graduated, categorized symbols), working with attributes, QGIS messages, QGIS built-in scripts, Editing vector layers and features. Working with raster data: digital elevation models and satellite images.

Plugins in QGIS: standard and processing plugins. Creating plugins from scripts.

A számonkérés és értékelés rendszere: practical course mark based on course work.

Kötelező irodalom:

* QGIS online Documentation, PyQGIS Developer Cookbook: <https://docs.qgis.org/3.4/en/docs/pyqgis_developer_cookbook/>
* Gary Sherman: PyQGIS Programmer’s Guide. Extending QGIS 3 with Python 3. LocatePress LLC. ISBN: 9780998547725

Ajánlott irodalom:

* QGIS Plugins: <https://plugins.qgis.org/>

**Tárgy neve: Dedicated Geospatial Information Systems**

Tárgyfelelős neve: Dr. Jung András

Tárgyfelelős tudományos fokozata: habil. PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

Az oktatás célja:

a, knowledge

- Comprehensive knowledge of the problem-solving principles, methodology and processes of the planning, development and operation processes of the geoinformatics field, especially in the following areas: database management, Big Data data-mining, primary and secondary data collection, Earth observation, spatial and temporal data analysis, modelling and simulation of processes, network analysis, 3-dimensional modelling, geovisualization, geostatistical solutions, web-based geoinformatics services, spatial services development, geoinformatics programming, development of geospatial applications, open-source geoinformatics.

- Knowledge of the specific tools of geoinformatics, ability to apply field survey procedures, data management and analysis, and visualization solutions. Knowledge and use of spatial data collection technologies, available databases and spatial information software, as well as open-source and commercial geoinformatics software, cloud-based geoinformatics solutions.

- Understandings, knowledge and application of mobile field, laboratory and practical materials, tools and methods of geoinformatics.

b, abilities

- Ability to creatively and methodically process, evaluate, interpret and analyse measurement results and draw conclusions from them.

- Ability to collect data independently and organize spatial data into a database, as well as to organize the data with the tools of geoinformatics. Ability to perform operations and models with independently organized databases.

- Ability to recognize and apply new problem-solving methods and procedures in his/her field and apply what he/she has learnt in a diverse, multidisciplinary environment.

c, attitude

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

Az oktatás tartalma: This course introduces how geospatial information system applications serve the public or community´s interest and needs. Special attention will be paid to environmental or urban geospatial information systems. Furthermore, geospatial information systems will be discussed for the health sector, land use and -design process, telecommunication, transport, resource management, supply networks and -chains. Business-related applications will be presented as well, such as geomarketing, LBS and mobile LBS with community interest. A general overview will be given about domestic and international tendencies, visions and forecasts, development practices and theories, while considering human resources and the labour market perspectives. After completing the course, the students will be able to classify, select or evaluate geospatial information systems to make better geospatial decisions.

A számonkérés és értékelés rendszere: oral and/or written exam.

Kötelező irodalom:

* Tian, B. (2016). GIS technology applications in environmental and earth sciences. CRC Press, ISBN 9781498776042
* Vieux, Baxter E. (2016). Distributed hydrologic modeling using GIS. Springer, ISBN 978-94-015-9710-4
* De Smith, M. J., Goodchild, M. F., & Longley, P. (2007). Geospatial analysis: a comprehensive guide to principles, techniques and software tools. Troubador publishing ltd., ISBN 13 978-1-912556-05-2

Ajánlott irodalom:

* Heritage, S. N. (2018). EcoServ-GIS v. 3.3: A toolkit for mapping ecosystem services (GB scale).
* Rai, P. K., and Nathawat, M. S. (2017). Geoinformatics in Health Facility Analysis. Springer, ISBN 978-3-319-44624-0
* Estaville, Lawrence E. (2012). Geospatial workforce trends in the United States. In Geospatial Technologies and Advancing Geographic Decision Making: Issues and Trends, pp. 82-89. IGI Global, ISBN 9781466602588

**Tárgy neve: Spatial process model building**

Tárgyfelelős neve: Dr. Gede Mátyás

Tárgyfelelős tudományos fokozata: habil. PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

**Objectives:**

* Knowledge of the main contexts and laws of the field of geoinformatics, and of the simple IT procedures applied to them.

o Knowledge of the concepts and terminology of geoinformatics in his/her mother tongue

**Ability to:**

o Ability to produce and professionally use a variety of spatial databases

o Ability to perform **complex** analyses and to publish the results in an understandable way

o Understand the processes and scientific **(geoinformatic)** problems that can be investigated and then test them using appropriate methods accepted in scientific practice.

o Ability to map and visualise data in geospatial information systems, organise spatial and relational data into databases, operate databases, perform spatial analysis, and perform simple analyses using statistical methods and geoscientific tools.

o Ability to carry out subtasks of research projects.

**Attitude:**

o Checks and realistically evaluates the results of his/her own work.

o Open to professional exchange.

o Open to continuing education in science and non-science.

o Committed to learning new competences, to expanding his/her worldview and knowledge of his/her field.
o Open to new perspectives in science and technology, and to open communication and exchange of ideas.

**Autonomy and responsibility:**

o Ability to think independently about basic professional questions and to answer them on the basis of given sources.

o Assumes responsibility for a scientific worldview.

o Collaborate responsibly with professionals in science and in other disciplines.

o Consciously embrace ethical standards of the profession.

**Content of education [concise description of the knowledge to be acquired]:**

During the course, students are introduced to FME software (Feature Manipulation Engine) that is able to create complex workflows of geospatial processes, visualize and reproduce results of geospatial analyses. By the end of the course, students are familiar with and proficient in the use of the listed file formats (shp, csv, laz, proj) and certain geoprocessing procedures (trimming, merging, linking). The aim of the course is to enable students to see not only subtasks when developing a project, but to be able to see the whole process with its spatial and theoretical context. The course requires a complex use of data manipulation in Qgis and in ArcGIS, and also database management in SQL language.

**Examination and assessment scheme:** practical mark based on course work

Independent completion of a semester assignment based on given parameters, including: database construction, data collection, relational database design, use of transformers, data acquisition and interpolation.

**Literature**

**Obligatory:**

* <https://engage.safe.com/training/recorded/fme-desktop-basic-2022-1/>
* [*https://s3.amazonaws.com/gitbook/Desktop-Intro-2020/Desktop-Intro-2020.pdf*](https://s3.amazonaws.com/gitbook/Desktop-Intro-2020/Desktop-Intro-2020.pdf)

**Recommended:**

* Roger Tomlinson: Thinking about GIS. ESRI Press, Redlands, USA, 2007
* [https://desktop.arcgis.com](https://desktop.arcgis.com/)

**Tárgy neve: Introduction to QGIS**

Tárgyfelelős neve: Dr. Ungvári Zsuzsanna

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

**Purpose of education:**

**a) knowledge**

 - Comprehensive knowledge of the principles, methods and procedures for the design, development and operation of geoinformatics, in particular in the following areas: operating systems and database management, design and development of web-based geoinformatics tools and services, geoinformatics-related programming principles, geospatial application development.

 -Knowledge of the specific tools of the field of cartography and geoinformatics, the mathematical and cartographic principles of editing maps for different purposes, the ability to apply survey procedures, representational solutions and various reproduction technologies.

 - Ability to create maps and geoinformatics systems that can be used by economic sectors or clients in the desired field.

**b) abilities**

 - Ability to interpret and formalise complex professional problems in the field of cartography and geoinformatics, to identify the necessary theoretical and practical background and to solve the problem. Ability to provide consultancy, problem-solving, design, development, operation and management of cartographic and geoinformatics systems, decision support systems and expert systems.

 - Ability to interpret, plan, organise, manage and control processes in the field of cartography and geoinformatics.

- Ability to learn and apply new problem-solving methods and procedures in the field.

**c) attitude**

- It monitors professional and technological developments in the field of cartography and geoinformatics and the opportunities that will enable it to work in the public sector, in various companies or to set up and run its own business.

- Shares his/her own knowledge and values the dissemination of professional results in cartography and geoinformatics.

- It is committed to meeting and enforcing quality standards (accuracy, commitment).

 **d) autonomy and responsibility**

 - Able to work independently in IT, carrying out tasks, thinking through and developing technical issues in a self-directed manner and at a pace.

 - Responsible for meeting and enforcing deadlines. Assumes responsibility for his/her own work and that of his/her colleagues working under his/her direction and with him/her (in a project).

 - In the case of mission-critical mapping and geoinformatics systems, may be given development and operational responsibility appropriate with his/her professional competences.

**Content of education:**

The course aim is to introduce those students into the application into QGIS, whose do not have enough practice in it. The topics, which appears in the course:

Vector formats: GPKG, Shapefile, GPX, GeoJSON

Layers.

Symbology: single, graduated, categorized, rule-based. Styling map features. Map editing rules.

Labeling: single labels, rule-based labelling

Selection and querying in QGIS

Visualization of thematic data, importing textfiles, working with statistical data. Joins. Diagrams. Creating thematic maps at 1:500 000 scale.

Layout.

Working with raster data. The Geotiff format. Georeferencing.

Basic and advanced drawing tools in QGIS. Vectorization.

Working with digital terrain models: hypsometric tint, contour lines generation, hill shading. 3D View. Elevation profile.

Working with satellite images, NDVI index.

Important QGIS plugins.

**Evaluation system**: practical course mark based on course work.

**Literature:**

**Obligatory:**

The newest QGIS online documentation: <https://www.qgis.org/>

* Menke, K.: Discover QGIS 3.x: A Workbook for Classroom or Independent Study. Locate Press. 406 p. 2019 ISBN: 9780998547763

**Recommended:**

* Sherman G.: The PyQGIS Programmer's Guide: Extending QGIS 3 with Python 3. Locate Press. 252 p. 2018. ISBN: 9780998547725

**Tárgy neve: Introduction to ArcGIS**

Tárgyfelelős neve: Dr. Pál Márton

Tárgyfelelős tudományos fokozata: PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

**The aim of education:**

**a) knowledge**

- He/she has a complex knowledge of the general cartographic, geographic, mathematical and informatics principles, rules and interrelationships necessary for the practice of cartography and geoinformatics, in particular in the following subjects: surveying (geodesy, topography, remote sensing, photogrammetry), map construction and design, projection, thematic cartography, geovisualisation, geoinformatics, building geographic information systems.

- Comprehensive knowledge of the principles, methods and procedures for the design, development and operation of geoinformatics, in particular in the following areas: operating systems and database management, design and development of web-based geoinformatics tools and services, geoinformatics-related programming principles, geospatial application development.

- Knowledge of the specific tools of the field of cartography and geoinformatics, the mathematical and cartographic principles of editing maps for different purposes, the ability to apply survey procedures, representational solutions and various reproduction technologies.

- They have the basic organisational, managerial and leadership skills to perform managerial tasks related to their field of specialisation and the entrepreneurial skills to provide business consultancy, set up and run a business in the field of cartography and geoinformatics.

**b) abilities**

- Ability to interpret and formalise complex professional problems in the field of cartography and geoinformatics, to identify the necessary theoretical and practical background and to solve the problem. Ability to provide consultancy, problem-solving, design, development, operation and management of cartographic and geoinformatics systems, decision support systems and expert systems.

- Ability to interpret, plan, organise, manage and control processes in the field of cartography and geoinformatics.

- Ability to work pro-actively, in project (team) work with specialists in cartography and geoinformatics, co-disciplines and other disciplines (e.g. geodesy, geology, geophysics, geography, meteorology, astronomy, statistics, history, archaeology, linguistics).

**c) attitude**

- He/She monitors professional and technological developments in the field of cartography and geoinformatics and the opportunities that will enable it to work in the public sector, in various companies or to set up and run its own business.

- Shares his/her own knowledge and values the dissemination of professional results in cartography and geoinformatics.

- He/She is committed to meeting and enforcing quality standards (accuracy, commitment).

**d) autonomy and responsibility**

- Responsible for meeting and enforcing deadlines. Assumes responsibility for his/her own work and that of his/her colleagues working under his/her direction and with him/her (in a project).

- In the case of mission-critical mapping and geoinformatics systems, may be given development and operational responsibility appropriate with his/her professional competences.

**Content of education:**

During the semester, the student will learn basic solutions about ESRI's geospatial software. In addition to the theoretical knowledge of geospatial computing, the student will gain a basic insight into the use of the software tools provided by ArcGIS. They will confidently apply these in database management, database building, mapping, spatial analysis, remote sensing data processing and 3D visualisation analysis. Assessment will consist of five assignments over the semester.

Course outline:

* Basic database management and construction.
* Vector elements in ESRI software.
* Editing tools in ArcGIS Pro.
* Building topology in ArcGIS Pro.
* Vector data analysis.
* Raster data in ArcGIS Pro.
* Using remote-sensed data in ESRI software.
* Basics of 3D and ArcPy.

**Evaluation system**: practical course mark based on assignments.

**Literature:**

**Obligatory**

* Field, K. (2018). Cartography. ISBN: 9781589484399.
* Bonnie Shrewsbury & Barry Waite (2023). Top 20 Essential Skills for ArcGIS Pro. ISBN: 9781589487505
* Wilpen L. Gorr & Kristen S. Kurland (2023). GIS Tutorial for ArcGIS Pro 3.1. ISBN: 9781589487390

**Recommended**

* ESRI Map Book (2023). Vol. 38. ISBN: 9781589487444
* Field, K. (2021). Thematic Mapping: 101 Inspiring Ways to Visualise Empirical Data. ISBN: 9781589485570
* Lauren Bennett & Flora Vale (2023). Spatial Statistics Illustrated. ISBN: 9781589485709

**Tárgy neve: Terminology of Cartography and GIS**

Tárgyfelelős neve: Dr. Pál Márton

Tárgyfelelős tudományos fokozata: habil. PhD

Tárgyfelelős MAB szerinti akkreditációs státusza: AT

**Purpose of education:**

**a) knowledge**

 - Comprehensive knowledge of the principles, methods and procedures for the design, development and operation of geoinformatics, in particular in the following areas: operating systems and database management, design and development of web-based geoinformatics tools and services, geoinformatics-related programming principles, geospatial application development.

 -Knowledge of the specific tools of the field of cartography and geoinformatics, the mathematical and cartographic principles of editing maps for different purposes, the ability to apply survey procedures, representational solutions and various reproduction technologies.

 - Ability to create maps and geoinformatics systems that can be used by economic sectors or clients in the desired field.

**b) abilities**

 - Ability to interpret and formalise complex professional problems in the field of cartography and geoinformatics, to identify the necessary theoretical and practical background and to solve the problem. Ability to provide consultancy, problem-solving, design, development, operation and management of cartographic and geoinformatics systems, decision support systems and expert systems.

 - Ability to interpret, plan, organise, manage and control processes in the field of cartography and geoinformatics.

 - Ability to communicate, debate and report in written and oral form in the mother tongue and in at least one world language, using a high level of professional vocabulary in the field of competence.

**c) attitude**

- It monitors professional and technological developments in the field of cartography and geoinformatics and the opportunities that will enable it to work in the public sector, in various companies or to set up and run its own business.

- Shares his/her own knowledge and values the dissemination of professional results in cartography and geoinformatics.

- It is committed to meeting and enforcing quality standards (accuracy, commitment).

 **d) autonomy and responsibility**

 - Able to work independently in IT, carrying out tasks, thinking through and developing technical issues in a self-directed manner and at a pace.

 - Responsible for meeting and enforcing deadlines. Assumes responsibility for his/her own work and that of his/her colleagues working under his/her direction and with him/her (in a project).

 - In the case of mission-critical mapping and geoinformatics systems, may be given development and operational responsibility appropriate with his/her professional competences.

**Content of education:**

Following themes will be presented in lecture form or discussed in the group:

1. Developing the vocabulary of earth sciences (geology, meteorology)

2. Developing the vocabulary of related disciplines (astronomy, geography, history)

3. Developing the vocabulary of classical cartography (surveying, map projections)

4. Developing the vocabulary of geoinformatics (GIS, GPS, remote sensing)

5. Use of internet sources, technical dictionaries, glossaries, translation guides

Materials will be sent to the group a week ahead, which help the students prepare for the class. About half of the course will cover the above topics, while the other half will be flexibly adjusted to the interest of the students. Developing the language skills is also aimed. Presenting research interest by ppt will help students improve presentation techniques. Recommended homework will often be given.

**Evaluation system**: practical mark based on course work

**Literature:**

**Obligatory:**

* Basic Cartography 1−2. International Cartographic Association, 1984
* Science in the News. Voice of America, 1989

**Recommended:**

* H. Dreyfuss: Symbol Sourcebook. McGraw Hill, London, 1972

**Tárgy neve: Erasmus mobilitás – geoinformatika blokk**

**Tárgyfelelős neve**: Prof. dr. Zentai László

**Tárgyfelelős tudományos fokozata**: DSc

**Tárgyfelelős MAB szerinti akkreditációs státusza**: AT

**Erasmus mobility – geoinformatics courses**

**Purpose of education:**

a, knowledge

- the professional knowledge described in geoinformatics courses at a foreign university.

b, abilities

- Independent problem-solving, decision-making on technical issues, in the field and in an office environment

- Structuring, planning and carrying out complex tasks

- Developing vocabulary and professional expression in oral and written reports

c, attitude

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

**Content of education:**

Recognition and equivalence of courses in geoinformatics completed abroad up to a maximum of 15 credits.

**Evaluation system:** according to the completed course

**Literature**

**Obligatory:**

* All written material of the topic of the course

**Recommended:**

* All written material of the topic of the course

**Tárgy neve: Internship**

**Tárgyfelelős neve**: dr. Gede Mátyás

**Tárgyfelelős tudományos fokozata**: PhD

**Tárgyfelelős MAB szerinti akkreditációs státusza**: AT

**Purpose of education:**

a, knowledge

- An intensive synthesis of knowledge acquired in the previous years, covering all areas (research, programming, data presentation, drafting)

- Factual and problem-specific (detailed) knowledge of the specific task

- Knowledge of the partner institution in the case of an external data provider

b, abilities

- Independent problem-solving, decision-making on technical issues, in the field and in an office environment

- Structuring, planning and carrying out complex tasks

- Developing vocabulary and professional expression in oral and written reports

c, attitude

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

**Content of education:**

Students independently but driven by instructors of geoinformatics companies or institutes carry out a complex task on the basis of previous studies. The tasks must contain the interpretation of problem solving of a relevant topic in GIS environment or creating and interpretation of a complex spatial information system. The duration of the practice is 6 weeks (240 hours).

**Evaluation system:** signature of the partner company

**Literature:**

**Obligatory:**

* All written material of the topic of the practice

**Recommended:**

* All written material of the topic of the practice

**Tárgy neve: Degree thesis**

**Tárgyfelelős neve**: Prof. dr. Zentai László

**Tárgyfelelős tudományos fokozata**: DSc

**Tárgyfelelős MAB szerinti akkreditációs státusza**: AT

**Purpose of education:**

a, knowledge

- An intensive synthesis of knowledge acquired in the previous years, covering all areas (research, programming, data presentation, drafting)

- Factual and problem-specific (detailed) knowledge of the specific task

- Knowledge of the partner institution in the case of an external data provider

b, abilities

- Independent problem-solving, decision-making on technical issues, in the field and in an office environment

- Structuring, planning and carrying out complex tasks

- Developing vocabulary and professional expression in oral and written reports

c, attitude

- Accepts and adheres to the ethical principles of work and organizational culture, especially with regard to the copyright related to geoinformatics.

- Committed to adhering to and making others adhere to quality requirements.

d, autonomy and responsibility

- Independence regarding the thorough examination and elaboration of professional issues and processes.

- Feels responsible for meeting and making others meet the deadlines. He/she is responsible for his/her work and for his/her co-workers’ work in projects.

- With his/her knowledge and skills of geoinformatics, he/she cooperates responsibly with professionals in other fields.

**Content of education:**

Defining the structure of MSc thesis.Literature review on the topic of choice. Definition of goals.Tasks and subtasks description.Discussion and summary of the work. Completion of the tasks defined in the frame of the Thesis, in agreement with the course responsible or with another supervisor.

**Evaluation system:** Thesis and Presentation of a project report – Final exam

**Literature:**

**Obligatory:**

* All written material of the topic of the thesis

**Recommended:**

* All written material of the topic of the thesis