**Cartography MSc**  
**Nappali tagozat**  
**Tárgyleírások 2025/2026/1. félévtől**

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

**Tárgyfelelős neve**: dr. Zentai László

**Tárgyfelelős tudományos fokozata**: DSc

**Tárgyfelelős MAB szerinti akkreditációs státusza**: AT

**Purpose of Education:**

**a) Knowledge**

* In-depth understanding of the principles, methods, and procedures involved in the design, development, and operation of maps and other geoinformatic interfaces.
* Recognition of the importance of creative design in the development and management of both traditional and web-based cartographic and geoinformatics products, GIS tools, methods, and services.
* Thorough knowledge of general design principles, graphic rules, and functional relationships between graphic interfaces and user experience in both printed and digital media cartography and geoinformatics.

**b) Abilities**

* Ability to create maps and geoinformatics systems tailored for use by economic or public sectors, or clients within a specific field.
* Ability to analyze and formalize complex design, interface, and usability issues in the field of cartography and geoinformatics, identifying the necessary theoretical and practical background to address these challenges.
* Ability to provide consultancy, problem-solving, development, operational support, and management in the design of cartographic and geoinformatics systems aimed at improving decision-support and expert systems.
* Ability to interpret, plan, organize, manage, and control design and production processes within the fields of cartography and geoinformatics.

**c) Attitude**

* Continuously tracks professional and technological advancements related to visualization design in cartography and geoinformatics, staying informed about opportunities to work in the public sector, various companies, or to establish and manage a personal business.
* Willingly shares knowledge and values the dissemination of professional results in cartography and geoinformatics.
* Committed to maintaining and upholding quality standards (accuracy, diligence) and adhering to scientific ethical norms.

**d) Autonomy and Responsibility**

* Capable of working independently in IT, carrying out UX design tasks, and addressing technical issues in a self-directed manner and at an appropriate pace.
* Takes responsibility for meeting deadlines and ensures the completion of tasks. Assumes accountability for both personal work and the work of colleagues working under their direction within a project.
* In the case of mission-critical mapping and geoinformatics systems, development and operational responsibilities may be entrusted to individuals whose professional competencies align with the specific requirements.

**Content of education:**

- The concept of map. Scale, projection, generalization, legend. Classification of maps according to scale. Map types: base maps, topographic maps, thematic maps. Sources of map making.

-Maps for the public. Map types and functions. General characteristics, scale and legend. Additions to map information: inset maps, name index, searching grid.

-Printed maps. The process and phases of map production. The model map. Forming the map sheet, map frames. Technical symbols on the map. Legend and explanation of symbol

- Design theory in cartography: science and art. Graphic communication and user-oriented design. The use of visual language. Design thinking and product development.

- Map layout: the horizontal organization of the picture. Mapped data and graphic elements.

- Visual hierarchy: layering and separation. Layers of general map content: relief, general features, place names. Layers in thematic cartography.

-Map content. Different aspects of representation. Characteristics of objects and phenomena.

- Generalization: geographic ontology and map objects. Conceptual and graphic generalization. Symbolization: signs and symbols.

- Representation of the relief. Modern cartographic methods. Relationship between method, scale and map type of relief representation.

-Mapped data: groups and their cartographic representation. Main categories: hydrographic objects, settlements, transportation features, borders. 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: types of geographical names, writing systems. Place names, physical landscape regions, historical-geographical and administrative regions. Names of linear elements, hydrographic names Names of public domains. Supplementary textual information on maps. Pictograms.

- Narrative cartography: visual storytelling. Time in cartography, spatiotemporal representation: animation and multimedia.

- User experience and interaction design (UX/IxD) in cartography and GIS.

**Evaluation system:** oral and/or written exam.

**Literature:**

**Obligatory:**

* Kraak, M.-J., Ormeling, F. (2020) Cartography: Visualization of Geospatial Data. Fourth Edition. CRC Press. ISBN 9781138613959
* Kryger, John – Wood, Denis (2016): Making Maps. A Visual Guide to Map Design for GIS: Guilford Press, New York-London. (ISBN: 9781462509980)
* Dodge, M., Kitchin, R. - Perkins, C. (2009). Mapping: A Critical Introduction to Cartography and GIS. Wiley-Blackwell. ISBN: 978-1405123884

**Recommended:**

* Brewer, C. A. (2015) Designing Better Maps: A guide for GIS users. First edition. Esri Press. ISBN: 9781589484405
* Munzner, Tamara (2013): Visualization. Analysis and Design. CRC Press, Boca Raton. (ISBN 9781466508910)
* Cairo, Alberto (2013): The Functional Art. An introduction to information graphics and visualization. New Riders, Berkeley. (ISBN 9788998139285).
* Field, K. (2018) Cartography. First edition. Esri Press. ISBN-13: 978-1589484399
* Menno-Jan Kraak, Robert E. Roth, Britta Ricker, Ayako Kagawa and Guillaume Le Sourd: Mapping for a sustainable world. UN; International Cartographic Association, 2020, <https://digitallibrary.un.org/record/3898826?v=pdf>

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

**Tárgyfelelős neve**: dr. Reyes Nunez José Jesús

**Tárgyfelelős tudományos fokozata**: PhD

**Tárgyfelelős MAB szerinti akkreditációs státusza**: AT

**Purpose of education:**

**a) knowledge**

**a) Knowledge**

* In-depth understanding of the principles, methods, and procedures involved in the design, development, and operation of maps and other geoinformatic interfaces.
* Recognition of the importance of creative design in the development and management of both traditional and web-based cartographic and geoinformatics products, GIS tools, methods, and services.
* Thorough knowledge of general design principles, graphic rules, and functional relationships between graphic interfaces and user experience in both printed and digital media cartography and geoinformatics.

**b) Abilities**

* Ability to create maps and geoinformatics systems tailored for use by economic or public sectors, or clients within a specific field.
* Ability to analyze and formalize complex design, interface, and usability issues in the field of cartography and geoinformatics, identifying the necessary theoretical and practical background to address these challenges.
* Ability to provide consultancy, problem-solving, development, operational support, and management in the design of cartographic and geoinformatics systems aimed at improving decision-support and expert systems.
* Ability to interpret, plan, organize, manage, and control design and production processes within the fields of cartography and geoinformatics.

**c) Attitude**

* Continuously tracks professional and technological advancements related to visualization design in cartography and geoinformatics, staying informed about opportunities to work in the public sector, various companies, or to establish and manage a personal business.
* Willingly shares knowledge and values the dissemination of professional results in cartography and geoinformatics.
* Committed to maintaining and upholding quality standards (accuracy, diligence) and adhering to scientific ethical norms.

**d) Autonomy and Responsibility**

* Capable of working independently in IT, carrying out UX design tasks, and addressing technical issues in a self-directed manner and at an appropriate pace.
* Takes responsibility for meeting deadlines and ensures the completion of tasks. Assumes accountability for both personal work and the work of colleagues working under their direction within a project.
* In the case of mission-critical mapping and geoinformatics systems, development and operational responsibilities may be entrusted to individuals whose professional competencies align with the specific requirements.

**Content of education:**

In this course, students engage in a hands-on cartographic design project, focusing on the development of creative design skills and design thinking. Studenst individually edit a digital base map for a given settlement (approx. resolution 1:10.000) and its environment using geoinformatics tools (in QGIS) using open GI. They form the base map sheet, add technical signs, record the hydrography (rivers and lakes, road network (including tourist routes), railway, land cover, draw the built-up areas (permanent buildings), edit administrative boundary lines, include geographical names and additional map nomenclature. Using their map, the groups are tasked with designing an outdoor setllement map (village or town district) that effectively showcases the local values, natural and cultural attractions and available services to both residents and tourists through a visually compelling graphic interface. For marketing purposes, students first create a map model based on the information gathered about the village/town,and then prepare a presentation to present their design. The groups visit the place and during a presentation they engage in on-site communication and discussion with the locals. This process simulates the operation of a cartographic business and the management of a cartographic-geoinformatics project, providing students with insight into real-world project environments. The on-site fieldwork and interactions with the town’s residents make the design thinking process an engaging and experiential learning opportunity.

**Evaluation system:** practical mark based on individual and team course work.

**Literature:**

**Obligatory:**

* Kryger, John – Wood, Denis (2016): Making Maps. A Visual Guide to Map Design for GIS: Guilford Press, New York-London. (ISBN: 9781462509980)
* Dent, B. – Torguson, J.S. – Hodson, T.W. (2008): Cartography. Thematic Map Design. (6th edition), McGraw Hill, Boston. (ISBN 9780072943825)

**Recommended:**

* Robinson, Arthur H. (1952): The look of maps. An examination of cartographic design. University of Wisconsin Press, Madison (ISBN 9781589482623)
* Raisz, E. (1948) General Cartography. McGraw-Hill Book Company: New York.
* Edward Tufte (2001): Envisioning information. Plenum Press, Boston, ISBN: 9780961392116
* Menno-Jan Kraak, Robert E. Roth, Britta Ricker, Ayako Kagawa and Guillaume Le Sourd: Mapping for a sustainable world. UN; International Cartographic Association, 2020, <https://digitallibrary.un.org/record/3898826?v=pdf>
* Crampton, Jeremy (2010): Mapping: a critical introduction to cartography and GIS. Wiley-Blackwell. ISBN-13: 978-1405121729

**Tárgy neve: Geovisualization**

**Tárgyfelelős neve**: dr. Albert Gáspár

**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.

- 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.

- 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 apply what has been learned in a diverse, multidisciplinary professional environment.

**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:**

This course introduces the human segment of user cognitive visualisation skills, which is fundamental for the application of geoinformatics technology. The tools for this cognitive process are geovisualisation tools, maps and other cartographic-spatial representation formats. Topics covered during the semester:

* + The concept of visualisation. Types of visualisation. Geovisualization and geovisual analysis.
  + The concept of map variables and the model property of the map: a theoretical cartographic overview. The cartographic cube (MacEachren).
  + Cognitive functions of map: dynamic relationship between map types and use in spatial cognition.
  + The organisation of graphic space: the use of visual language and visual dynamics (Tufte). The role of colours in cartography.
  + Application of graphic semiotics in data visualisation. Data relations and visual variables (Bertin).
  + Interpretation and representation of time in geovisualisation. Animation and multimedia.
  + The visual interface: layout and visual hierarchy. Gestalt principles. Interactive geovisualisation and visual storytelling.
  + Geovisualisation and mass communication: information, propaganda, community mapping and critical cartography. The theory of the development of spatial cognition (maps for education, Piaget).
  + User-oriented research in geovisualisation and geoinformatics: physiological and psychological studies. Special user groups.

**Evaluation system**: oral and/or written exam.

**Literature:**

**Obligatory:**

* 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

**Recommended:**

* Jacques Bertin 1983: Semiology of Graphics. Diagrams, networks, maps. Univ. of Wisconsin Press, Madison, 1983. ISBN: 9780299090609.
* Edward Tufte 2001: Envisioning information. Plenum Press, Boston, ISBN: 9780961392116
* Daniel Keim, Jörn Kohlhammer, Geoffrey Ellis, Mansmann 2010: Mastering the Information Age. Solving Problems withVisual Analytics. Eurographics Association, Goslar. ISBN: 9783

**Tárgy neve: Basics of Soil Science, Hydrology and Agriculture**

**Tárgyfelelős neve**: dr. Jung András

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

**Tárgyfelelős MAB szerinti akkreditációs státusza**: AT

**Purpose of education**

1. **Knowledge**

* Students have basic knowledge about the processes of soil formation and the characteristics of different soil types. Starting from the fundamentals, they understand how soil develops, what factors influence soil quality, and recognize the characteristics of various soils.
* Students possess general hydrological knowledge, including the areas of water movement, water balance, and water management. They understand surface and subsurface water processes and their effects on the environment and agriculture.
* Students have theoretical and practical knowledge in the field of agricultural science. They understand the principles of sustainable crop cultivation and animal husbandry, and are able to apply these principles in practice. Through their foundational knowledge of various aspects of agriculture, they can reflect on agricultural economic challenges.

1. **Abilities**

* Students are capable of analyzing the structure, composition, and factors affecting soils with an analytical approach. They are familiar with various soil classification systems and practical applications in agriculture. They can conduct soil sampling and plan laboratory tests to determine soil nutrient content.
* Students understand the fundamental processes of the hydrological cycle and its connection to agricultural management. They can choose modeling tools for analyzing water movement and water balance, comprehend the challenges of water management, and propose more efficient water management strategies.
* Students have knowledge of sustainable agricultural methods and their application.

1. **Attitude**

* Students are aware of the role of soil and water in environmental conservation. They consider sustainable agricultural management important and are committed to practices that minimize environmental impacts.
* Students are curious and motivated towards soil science and hydrological research, and they are open to new scientific findings related to agriculture. They seek opportunities for scientific exploration and actively participate in projects or research groups.
* Students appreciate the economic impacts of agricultural practices and the importance of sustainability in agricultural operations.

1. **Autonomy and responsiblity**

* Students are capable of learning independently and acquiring information in the fields of soil science, hydrology, and basic agricultural knowledge. They actively engage in self-improvement, such as studying literature and participating in further training.
* Students take responsibility for applying the knowledge they acquire, especially in the areas of agricultural economics and environmental conservation. They are dedicated to sustainable agriculture and efficient management of natural resources, contributing to the development of agriculture through their activities.
* Students recognize the social role of agriculture and are willing to participate in initiatives that promote rural development and food security. They are aware of the social and ethical issues that may arise in the agricultural sector and take responsibility for supporting sustainable, socially accepted practices.

**Content of education**

Students become familiar with the fundamental concepts of soil science, hydrology, and agriculture. In acquiring soil science knowledge, they analyze the physical, chemical, and biological properties of soil, understand soil formation processes, and study methods of soil conservation. In the field of hydrology, they learn about the water cycle, soil moisture, and water movement processes, as well as grasp the fundamentals of water use planning and water management strategies. As part of basic agricultural knowledge, they review the principles of agricultural economics and rural development, establish connections between natural resources and agricultural production, and gain insight into sustainable agricultural practices. The subject offers practical applications and project-based learning opportunities, aiming to provide students with a solid foundation for professional preparation in agriculture and agricultural environmental protection.

**Topics:**

Basics of Soil Science

Soil Formation and Development

Soil Water Management

Soil Conservation and Land Use

Soil Cultivation and Agricultural Production

Impact of Livestock on Soil

Fundamentals of Hydrology

Precipitation and Evaporation

Groundwater Resources

Water Quality and Water Use

Hydrometeorological Analyses

Ecological Perspectives

Water Management Strategies

Impact of Climate Change

Integrated Agriculture and Water Management

**Evaluation system:** oral and/or written exam.

**Literature:**

**Obligatory:**

* Brady, N. C., Weil, R. R., & Weil, R. R. (2016). The nature and properties of soils, ISBN 9780133254488, Pearson publishing,
* SoilWeb200. 2014. On-line teaching tool for the APBI (formerly SOIL) 200 course, developed by Dr.Krzic’s team available at <http://soilweb200.landfood.ubc.ca/>
* Tim Davie. 2008. ISBN 0-203-93366-4. Fundamentals of Hydrology. Internet: <https://web.archive.org/web/20160804121158id_/http://www.univpgri-palembang.ac.id:80/perpus-fkip/Perpustakaan/Geography/Geografi%20Fisik/Hidrologi%20Dasar.pdf>
* Tühnen Institute. Agricultural Production: <https://literatur.thuenen.de/digbib_extern/dn059499.pdf>
* Bayer: The Future of Agriculture and Food. Internet: https://www.bayer.com/sites/default/files/factbook.pdf

**Recommended:**

# Soil Science Crash Course: <https://www.youtube.com/watch?v=zD3zaootOkQ>

* W. Lee Daniels, Kathryn C. Haering. Chapter 3. Concepts of Basic Soil Science. Internet: <http://www.soilphysics.okstate.edu/teaching/soil-4683-5683/references/concepts%20of%20basic%20soil%20science.pdf>
* Introduction to Soil Science. Internet: <https://lfs-ubcfarm-clone-2018.sites.olt.ubc.ca/files/2019/06/2016_Winter_APBI-200-1.pdf>
* David R. Maidment. Handbook of hydrology. Internet: <http://dl.watereng.ir/HANDBOOK_OF_HYDROLOGY.PDF>

**Tárgy neve**: **History of Cartography**

**Tárgyfelelős neve**: dr. Pál Márton

**Tárgyfelelős tudományos fokozata**: PhD

**Tárgyfelelős MAB szerinti akkreditációs státusza**: AT

**Purpose of education**

**Knowledge:**

* Understands the historical processes of map-making and the development of scientific cartography, along with the theoretical foundations of multidisciplinary research that explores the cognitive and social aspects of these fields.
* Is familiar with the historical development of map representations, its major periods, key figures, and significant maps. Knows the most important domestic and international cartographers, organizations, institutions, as well as the most important maps and other cartographic representations.
* Understands the basics of processing and evaluating historical cartographic documents, both structurally and content-wise, and can apply these results in professional and educational publications.

### **Abilites:**

* Understands the historical context of cartographic processes and can recognize development trends.
* Based on his/her knowledge of cartographic history, is capable of describing old maps and cartographic representations, interpreting cartographic data and information, and critically analyzing measurement results.
* Can read old maps, recognize spatial relationships, evaluate graphic information, and present results effectively.

### **Attitude:**

* Strives to understand the historical relationship between nature and human society.
* Is aware of the cultural significance of the graphic statements made in maps and other visualizations, as well as their social impact.
* Ensures that the results of his/her independent research work are verified according to scientific criteria and realistically evaluated.

### **Autonomy and Responsibility:**

* Is capable of independently considering fundamental professional questions and providing answers based on available sources.
* Cooperates responsibly with experts in the field of history and other disciplines.
* Consciously follows scientific ethical norms in cartographic and geoinformatics work.

**Content of education**

Introduction: general overview of the history and current trends in map history and the history of cartography. National and international organization of the history of cartography.

The development models of cartography as a scientific discipline. Positivist, postmodern and critical cartography: power, politics and ideology.

Processual cartography and mapping modes. The History of Cartography Project.

Maps in the Ancient times and in the Classic Antiquity. Ptolemy: the geography as a world map. The symbolism of medieval map: European and Islamic mapping.

Renaissance cartography in Europe. Maps of the geographical discoveries. Atlases: Ortelius and Mercator. Map printing and distribution.

Modern cartography in the European Enlightenment. The idea of the modern map: accuracy and completeness. The Cassini map and the great surveys

Cartography as power: studies in colonial cartography (e.g. British India, Napoleonic Survey of Egypt, Colonial America)

The history of cartography in Hungary from Lazarus (1528) to Mikoviny. The reformation of cartography (16-18th century).

Habsburg land surveys, military and Hungarian commercial cartography, thematic mapping (19-20th century).

Old maps and new technologies: digitalization, publishing, visualization. The uses and changing role of the history of cartography.

Case studies and good practices: International map archives, exhibitions and applications (e.g.

GLAM-projects, cartographic heritage, Historical GIS, digital humanities.)

Presentation of the individual student projects, discussion and evaluation.

The actual problems in the history of cartography (guest lecture).

**Evaluation system:** oral and written exam.

Students will prepare a written paper (50%) on a map history topic of their choice, which must be approved by the instructor, following the provided processing criteria. They will give a presentation on the project results during a class session and answer questions (25%). They will respond to questions from the instructor related to the submitted paper in an oral exam (25%).

**Literature:**

**Obligatory:**

* Norman J. Thrower: Maps and Civilization: Cartography in Culture and Society, University of Chicago Press, Chicago-London, 2008.
* Török, Zsolt G.: Renaissance Cartography in East-Central Europe. c. 1450-1650. In: Woodward, D (ed.).: The History of Cartography, Vol. 3, University of Chicago Press, Chicago- London, 2007, pp. 1806-1851. (online: <https://press.uchicago.edu/books/hoc/HOC_V3_Pt2/HOC_VOLUME3_Part2_chapter61.pdf>
* Liebenberg, E. – Collier, P. – Török, Z.G. (eds): History of Cartography. International Symposium of the ICA. Springer, Berlin –Heidelberg, 2013.

**Recommended**

* Harley, J.Brian: Deconstructing the map. Cartographica, 32.1. 1989.
* Edney, Matthew: Cartography. The ideal and its history. Univ. of Chicago Press, Chicago, 2019.
* The History of Cartography. Relevant chapters from Volumes 1-6 (available online). The University of Chicago Press, Chicago-London. 1987- 2026. [History of Cartography: Volumes One, Two, Three, Four, and Six](https://press.uchicago.edu/books/HOC/index.html)
* Buga L. – Török, Z. G. (eds.) Surveying and Mapping. In: Kocsis, K. (Ed.) 2024. National Atlas of Hungary – State and Nation. Budapest, HUN-REN. Chapter 3. pp. 22-35. (<https://nemzetiatlasz.hu/MNA/National-Atlas-of-Hungary_Vol1_Ch3.pdf>

**Tárgy neve**: **Map projections 1 L**

**Tárgyfelelős neve**: dr. Kerkovits Krisztián

**Tárgyfelelős tudományos fokozata**: PhD

**Tárgyfelelős MAB szerinti akkreditációs státusza**: AT

**Map projections 1**

**Purpose 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, map projections

- Knowledge of the specific tools of the field of cartography and geoinformatics, the mathematical and cartographic principles of editing maps for different purposes.

- Ability to evaluate, use as source material and process as a database national and foreign, old and new maps and other cartographic publications (globes, sky globes, relief maps, etc.).

**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 apply what has been learned in a diverse, multidisciplinary professional environment.

- 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**

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

- It 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:**

* 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

**Evaluation system**: oral and/or written exam

**Literature:**

**Obligatory:**

* 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

**Recommended:**

* 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

**Purpose 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, map projections

- Knowledge of the specific tools of the field of cartography and geoinformatics, the mathematical and cartographic principles of editing maps for different purposes.

- Ability to evaluate, use as source material and process as a database national and foreign, old and new maps and other cartographic publications (globes, sky globes, relief maps, etc.).

**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 apply what has been learned in a diverse, multidisciplinary professional environment.

- 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**

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

- It 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:**

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

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

**Literature:**

**Obligatory:**

* 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

**Recommended:**

* 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 2.**

**Tárgyfelelős neve**: dr. Kerkovits Krisztián

**Tárgyfelelős tudományos fokozata**: PhD

**Tárgyfelelős MAB szerinti akkreditációs státusza**: AT

**Purpose 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, map projections

- Knowledge of the specific tools of the field of cartography and geoinformatics, the mathematical and cartographic principles of editing maps for different purposes.

- Ability to evaluate, use as source material and process as a database national and foreign, old and new maps and other cartographic publications (globes, sky globes, relief maps, etc.).

**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 apply what has been learned in a diverse, multidisciplinary professional environment.

- 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**

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

- It 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:**

* 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

**Evaluation system**: oral and/or written exam

**Literature:**

**Obligatory:**

* 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

**Recommended:**

* 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: Dedicated geospatial information systems**

**Tárgyfelelős neve**: dr. Jung András

**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**:

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.

**Evaluation system:** oral and/or written exam.

**Literature:**

**Obligatory:**

* Pat Hohl, Keith Mann (Ed.) Delivering Water and Power: GIS for Utilities (Applying GIS, 1). ISBN: 1589486757, Esri Press (2021),
* Terry Bills, Keith Mann (Ed.) Moving Forward: GIS for Transportation (Applying GIS, 4). ISBN: 1589486927, Esri Press (2021)

**Recommended:**

* Estaville, Lawrence E. "Geospatial workforce trends in the United States." In Geospatial Technologies and Advancing Geographic Decision Making: Issues and Trends, pp. 82-89. IGI Global, 2012. ISBN: 9781466602588

**Tárgy neve: Color theory and typography in cartography**

**Tárgyfelelős neve**: Dr. José Jesús Reyes Nunez

**Tárgyfelelős tudományos fokozata**: PhD

**Tárgyfelelős MAB szerinti akkreditációs státusza**: AT

**The purpose of the education:**

1. **knowledge**

 It comprehensively describes the task-solving principles, methods and procedures of the planning, development, and operation processes in the field of publication editing.

 Provides complex knowledge in the field of general text wrapping, text and image manipulation principles, rules, and connections necessary for cultivating the field of publication editing.

 Ability to create digital documents that can be published as publications.

**b) abilities**

 Ability to interpret and formalize complex professional problems in the field of publication editing, to reveal the necessary theoretical and practical background and to solve the problem.

 Ability to interpret, plan, organize, manage, and control processes belonging to the field of expertise.

 Ability to apply what he has learned in a diverse, multidisciplinary professional environment.

**c) attitude**

 Monitors professional and technological development in the field of publication editing.

 Shares his/her own knowledge and considers it important to convey professional results.

 Committed to observing and enforcing quality requirements (accuracy, commitment).

**d) autonomy and responsibility**

 Suitable for an independent publication editor's position, in which he carries out his tasks in a manner and at a pace set by himself, thinking through, and working out professional issues.

 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).

​

**Content of education:**

 Basic concepts of typography: fonts, segmentation, layout, repetition, contrast, guiding lines, planned white surfaces; Font catalog. Paper sizes, proportions golden ratio.

 Specificities of publications. Parts of the book and the map. Title quarter sheet (Title page, copyright, colophon). Letter selection.

 Address system. Paragraphs. Highlights. Blind text.

 List. Bibliography. Footnote. Final note. References.

 Color theory. Pictures, figures, graphs.

 Tables, mathematical and chemical typing.

 Table of contents, PDF export; Printing marks

 Proofreading signs

 Typographic information for electronic publications: deviations from the rules of printed publications, color mixing

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

**Literature:**

**Obligatory**

* F. Javier Gomez Lainer: *InDesign 2022*, Anaya Multimedia, 2021
* Shufflebotham Robert: *InDesign in Easy Steps*, In Easy Steps Ltd, 2021

**Recommended**

* Gavin Ambrose-Paul Harris: *The Fundaments of Typography*, AVA Publishing, 2011
* Ellen Lupton: *Thinking with Type*, Princeton Architectural Press, 2004
* Robert Bringhurst: The Elements of Typographic Style, Hartles&Marks, 2004

**Tárgy neve: Photogrammetry and remote sensing L**

**Tárgyfelelős neve**: Dr. Jung András

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

**Tárgyfelelős MAB szerinti akkreditációs státusza**: AT

**Purpose of education**

1. **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.

- 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 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) atitude**

- Open and committed to critical feedback and evaluation based on self-reflection. Adopts and enforces with co-workers ethical principles of work and organizational culture, with particular attention to the copyright environment related to cartography and geoinformatics.

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

- It attaches importance to the promotion and implementation of environmental awareness and sustainable development, and promotes this through the tools of cartography and geoinformatics.

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:**

During the lectures, students gain insight into the theoretical foundations, technical background, and methods of photogrammetry and remote sensing. They become familiar with both imaging and non-imaging optical data collection, data processing, and their application possibilities. We overview the current state of active and passive remote sensing in terrestrial, aerial, and satellite systems, as well as its multidisciplinary context according to the current state of science. Emphasis is placed on industrial applications and their scientifically oriented approaches. We delve into the basics of digital image processing, general issues, related software, measurement results, and their usability. After the course, students will be able to form independent professional opinions and make choices regarding methods, software, and hardware.

**Topics**

Introduction to Photogrammetry and Remote Sensing

Optical Data Collection

Fundamentals of Data Processing

Remote Sensing Instrument Systems

Multidisciplinary Approach in Remote Sensing

Industrial Applications and Scientific Approach

Theory and Practice of Digital Image Processing

Related Software and Hardware

Evaluation of Measurements and Usability

Professional Opinion Formation and Method Selection

**Literature:**

**Obligatory:**

* Elachi, Charles, and Jakob J. Van Zyl. (2021) Introduction to the physics and techniques of remote sensing. John Wiley & Sons, ISBN 9781119523123
* Richards, John A., and John A. Richards. (2022) Remote sensing digital image analysis. Vol. 5. Berlin/Heidelberg, Germany: springer, ISBN 978-3-030-82327-6
* 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

**Recommended:**

* 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: Photogrammetry and remote sensing P**

**Tárgyfelelős neve**: Dr. Jung András

**Tárgyfelelős tudományos fokozata**: PhD

**Tárgyfelelős MAB szerinti akkreditációs státusza**: AT

**Purpose of education:**

1. **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.

- 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 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) atitude**

- Open and committed to critical feedback and evaluation based on self-reflection. Adopts and enforces with co-workers ethical principles of work and organizational culture, with particular attention to the copyright environment related to cartography and geoinformatics.

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

- It attaches importance to the promotion and implementation of environmental awareness and sustainable development, and promotes this through the tools of cartography and geoinformatics.

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:**

During the practices, students gain insight into the theoretical foundations, technical background, and methods of photogrammetry and remote sensing. They become familiar with both imaging and non-imaging optical data collection, data processing, and their application possibilities. We overview the current state of active and passive remote sensing in terrestrial, aerial, and satellite systems, as well as its multidisciplinary context according to the current state of science. Emphasis is placed on industrial applications and their scientifically oriented approaches. We delve into the basics of digital image processing, general issues, related software, measurement results, and their usability. After the course, students will be able to form independent professional opinions and make choices regarding methods, software, and hardware.

**Topics**

The physical background of remote sensing, characteristics of different data types

Field equipments for optical data collection: measurement methodology and calibration of handheld multispectral and hyperspectral cameras and the spectroradiometer

Optical satellite systems: data sources and their characteristics, download options, procedures for improving spatial resolution, e.g. pansharpening

Optical satellite systems: pre-processing, data cleaning, characteristics and band composites

Optical remote sensing data classification possibilities and algorithms

Post-processing, cleaning, reclassification and change detection of remotely sensed data

Characteristics of radar remotely sensed data, preprocessing steps using SNAPTool, model creation (DEM/DSM)

Modeling of radar remotely sensed data: investigation of flood events, investigation of built-up areas

UAV systems and cameras

Photogrammetry solutions and software options; creating orthomosaics and DSM models, spherical modeling (Agisoft Metashape)

Features of LiDAR cameras; LiDAR point cloud processing, classification and modeling using LASTools

Thermal remote sensing: characteristics, data formats and cameras; evaluation methods

Dataspace Copernicus system usage knowledge, geoinformatics options, API and other connections

Student project work presentations

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

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

**Literature:**

**Obligatory:**

* Richards, John A., and John A. Richards. (2022) Remote sensing digital image analysis. Vol. 5. Berlin/Heidelberg, Germany: springer, ISBN 978-3-030-82327-6
* 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>

**Recommended:**

* 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: Measurements and data collection**

**Tárgyfelelős neve**: Dr. Kovács Béla

**Tárgyfelelős tudományos fokozata**: PhD

**Tárgyfelelős MAB szerinti akkreditációs státusza**: AT

**Purpose of education:**

**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 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.

**Content of education:**

* 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-cm 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

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

**Literature:**

**Obligatory:**

* 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

**Recommended:**

* 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: Thematic Cartography L**

**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 and understanding of the most important general theories, contexts, facts and related concepts in the field of cartography, in particular in the following areas: thematic cartographic representations, map design principles, cartographic software applications, cartographic principles and visualisation solutions for web mapping services.

- Knowledge of methods and tools for professional and effective written, oral and networked knowledge management in cartography and geoinformatics. Ability to evaluate, use as source material and process as a database national and foreign, old and new maps and other cartographic publications (globes, sky globes, relief maps, etc.).

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

**b) abilities**

- Ability to apply knowledge of cartography and geoinformatics in a creative and managerial manner.

- 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 apply what has been learned in a diverse, multidisciplinary professional environment

**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:**

A frontal lecture introducing the various subfields of thematic cartography, in the framework of which students will learn about the types and characteristics of thematic maps, the subject-specific methods of visual communication, and the graphical aspects of data processing. By the end of the semester, students will understand the theoretical and practical background of making thematic maps, and will be able to identify the content and graphical possibilities (and limitations) that are essential for the production of thematic (subject-specific) maps.

Course outline:

* + Theory of thematic cartography. The theory of generalisation. Editing principles.
  + Background maps. Data sources, data types and their critical evaluation. Methods of data clustering.
  + The development and history of thematic cartography.
  + Thematic mapping methods.
  + Characteristics of subject-specific maps. Maps of earth science. Maps of natural, economic and social processes.
  + Thematic maps in education. Thematic maps for specific uses. Thematic maps in communication: media maps, propaganda maps.
  + Information visualisation. The relationship between graphic symbols and thematic representation.
  + Thematic atlases.
  + Projections of thematic maps. The relationship between thematic maps and geoinformatics. On-line thematic cartography.
  + Editorial and data processing errors in thematic maps.
  + AR-VR-AI in thematic cartography. Programming thematic maps, online platforms 1.
  + Programming thematic maps, online platforms 2.

**Evaluation system**: oral exam, assessment on a five-point scale.

**Literature:**

**Obligatory**

* Cauvin, C., Escobar, F., & Serradj, A. (2013). Thematic Cartography, Thematic Cartography and Transformations. John Wiley & Sons.
* Field, K. (2018). Cartography. ISBN: 9781589484399.
* Lambert, N., & Zanin, C. (2020). Practical handbook of thematic cartography: Principles, methods, and applications. CRC Press. ISBN: 9780429291968.
* MacEachren, A. M. (1979). The evolution of thematic cartography: A research methodology and historical review. The Canadian Cartographer, 16(1), 17-33.

**Recommended**

* Slocum, T. A., McMaster, R. B., Kessler, F. C., & Howard, H. H. (2022). Thematic cartography and geovisualization. CRC Press.
* Field, K. (2021). Thematic Mapping: 101 Inspiring Ways to Visualise Empirical Data. ISBN: 9781589485570

**Tárgy neve: Thematic Cartography P**

**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 and understanding of the most important general theories, contexts, facts and related concepts in the field of cartography, in particular in the following areas: thematic cartographic representations, map design principles, cartographic software applications, cartographic principles and visualisation solutions for web mapping services.

- Knowledge of methods and tools for professional and effective written, oral and networked knowledge management in cartography and geoinformatics. Ability to evaluate, use as source material and process as a database national and foreign, old and new maps and other cartographic publications (globes, sky globes, relief maps, etc.).

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

**b) abilities**

- Ability to apply knowledge of cartography and geoinformatics in a creative and managerial manner.

- 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 apply what has been learned in a diverse, multidisciplinary professional environment

**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, students will work in teams, step-by-step, to create parts of a thematic atlas. In small groups, they work on two or three topics (chapters). To complete the task, they also have to collect material and data under the guidance of a tutor. The material produced should give a complex (comprehensive) picture of the topic. During the semester, the student will be able to independently structure and complete a major mapping assignment requiring research.

The student will submit a total of four thematic maps (2 of Europe, and 2 of countries) and two short essays for assessment by the end of the semester. Each assignment will be graded on a five-point scale. The end-of-semester grade is calculated as the average of these grades, using the rounding method commonly used at the University.

Course outline:

* Description of the assignment, grouping, and study of examples.
* Exploring the topics chosen, and editing background maps.
* Data collection, and map editing.
* Cartography.

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

**Literature:**

**Obligatory**

* Cauvin, C., Escobar, F., & Serradj, A. (2013). Thematic Cartography, Thematic Cartography and Transformations. John Wiley & Sons.
* Field, K. (2018). Cartography. ISBN: 9781589484399.
* Lambert, N., & Zanin, C. (2020). Practical handbook of thematic cartography: Principles, methods, and applications. CRC Press. ISBN: 9780429291968.
* MacEachren, A. M. (1979). The evolution of thematic cartography: A research methodology and historical review. The Canadian Cartographer, 16(1), 17-33.
* Field, K. (2018). Cartography. ISBN: 9781589484399.

**Recommended**

* Slocum, T. A., McMaster, R. B., Kessler, F. C., & Howard, H. H. (2022). Thematic cartography and geovisualization. CRC Press.
* Field, K. (2021). Thematic Mapping: 101 Inspiring Ways to Visualise Empirical Data. ISBN: 9781589485570

**Tárgy neve: Surveying and Topography L**

**Tárgyfelelős neve**: Dr. Varga Zsófia Krisztina

**Tárgyfelelős tudományos fokozata**: PhD

**Tárgyfelelős MAB szerinti akkreditációs státusza**: AT

**Purpose of education**

1. **knowledge**

- know the types of geodetic measurements, the most commonly used methods and instruments;

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

- knowledge of the structure and content of topographic maps and map databases;

- knowledge of the tools and processes of topographic survey and database construction;

- is familiar with the Hungarian state topographic map databases and the possibilities of using state data.

**b) abilities**

- is able to select the most appropriate geodetic data acquisition method for the given task, based on the technical accuracy requirements of the task;

- be able 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.

- be able to select the most appropriate state topographic mapping data for the task in hand, depending on the complexity of the task;

- be able to participate in the production of topographic maps and map databases.

**c) atitude**

- Familiarisation with geodetic survey methods and tools, data acquisition technologies and the acquisition of a map database approach will help to develop the right attitude towards professional cooperation with professionals working with public cartographic data in related fields.

- Open and committed to critical feedback and evaluation based on self-reflection. Adopts and enforces with co-workers ethical principles of work and organizational culture, with particular attention to the copyright environment related to 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 student will learn about the role of surveying and topography in mapmaking and spatial databases. The student will learn the basics of Global Navigation Systems, types of measurements and tools for surveying, and modern field data acquisition and topographic survey methods.

The course gives a general idea of the technologies and tools of topographic survey and database construction. It provides overview information on the state topographic maps and map databases of Hungary, the topographic mapping of the country, the available analogue and digital map series, the usability of state digital topographic map data. It introduces modern digital topographic map database development concepts and projects.

1. Introduction to the concepts of surveying and topography, the term of state topographic data and databases.

2. Geodetic measurements, measuring instruments. Measurement procedures, classical measuring instruments. Modern data acquisition technologies, point cloud.

3. GNSS surveying applications. Systems, measurement technologies, services.

4. Detailed survey. Basics of geodetic surveys.

5. Surveying base map, DAT, cadastral maps.

6. Basics of topographic mapping. Perspective, survey tools, survey techniques.

7. State topographic maps, databases. Historical overview of system maps, databases, their characteristics.

8. Creation of digital topographic map databases. Theoretical and technical basis, methods of implementation.

9. Restoration of topographic maps and databases

10. Quality control of survey works. Quality control system, documentation. State acceptance procedure.

Accuracy of topographic maps, databases.

12. Archiving of topographic maps.

13-14 Introduction to modern measuring instruments and practical demonstration of the process and technology of producing state topographic map databases and database-based map production in a visit to a military cartographic production facility

**Evaluation system**: oral or written exam

**Literature:**

**Obligatory:**

* 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

**Recommended:**

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

**Tárgy neve: Surveying and Topography P**

**Tárgyfelelős neve**: Dr. Varga Zsófia Krisztina

**Tárgyfelelős tudományos fokozata**: PhD

**Tárgyfelelős MAB szerinti akkreditációs státusza**: AT

**Purpose of education**

1. **knowledge**

- know the types of geodetic measurements, the most commonly used methods and instruments;

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

- knowledge of the structure and content of topographic maps and map databases;

- knowledge of the tools and processes of topographic survey and database construction;

- is familiar with the Hungarian state topographic map databases and the possibilities of using state data.

**b) abilities**

- is able to select the most appropriate geodetic data acquisition method for the given task, based on the technical accuracy requirements of the task;

- be able 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.

- be able to select the most appropriate state topographic mapping data for the task in hand, depending on the complexity of the task;

- be able to participate in the production of topographic maps and map databases.

**c) attitude**

- Familiarisation with geodetic survey methods and tools, data acquisition technologies and the acquisition of a map database approach will help to develop the right attitude towards professional cooperation with professionals working with public cartographic data in related fields.

- Open and committed to critical feedback and evaluation based on self-reflection. Adopts and enforces with co-workers ethical principles of work and organizational culture, with particular attention to the copyright environment related to 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:**

* 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

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

**Literature:**

**Obligatory:**

* 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

**Recommended:**

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

**Tárgy neve: Basic knowledge on land registry and copyright law**

**Tárgyfelelős neve:** Dr. Zentai László

**Tárgyfelelős tudományos fokozata:** DSc

**Tárgyfelelős MAB szerinti akkreditációs státusza:** AT

**Az oktatás célja angolul** *[Az előírt szakmai kompetenciáknak, kompetencia-elemeknek (tudás, képesség, attitüd, autonómia, felelősség) tömör leírása]*:  
**Purpose of education (competencies):**

***Knowledge:***

* Comprehensive knowledge and understanding of the most important general theories, contexts, facts and related concepts in the field of cartography and geoinformatics.
* Aware of the potential directions and limits of the professional area.
* 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 and representational solutions.
* 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.

***Capacities:***

* 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 assess the business, market and innovative value of the designed and implemented geoinformatics systems, their compliance with user and societal needs, validate the completed developments.

***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.
* Open and committed to critical feedback and evaluation based on self-reflection. Adopts and enforces with co-workers ethical principles of work and organizational culture, with particular attention to the copyright environment related to cartography and geoinformatics.
* It is committed to meeting and enforcing quality standards (accuracy, commitment).

***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.

**Az oktatás tartalma angolul** *[Az elsajátítandó ismeretanyag tömör leírása]/*

**Content of education:**   
The history of cadastral mapping in Hungary and Central Europe.

The history of land registration in Hungary and Central Europe.

Land registration, public authenticity, the land registration procedure.

The organisation of land registration and planning.

Current legislative environment.

Copyright law, works and performances protected by copyright.

Application of copyright law in cartography and geoinformatics.

**A számonkérés és értékelés rendszere angolul**

**Evaluation system**: K5 / 5-grades (written)  
Evaluation is based on an essay-type (written) classroom exam.

**Idegen nyelven történő indítás esetén az adott idegen nyelvű irodalom** *[2-5 kötelező és/vagy ajánlott irodalom]* ***/* Literature**:

***Obligatory:***

* Kenneth Reid, George Gretton: Land registration. Edinburgh University Press, 2016. ISBN 9781904968702
* UN-GGIM: Framework for Effective Land Administration. United Nations Committee of Experts on Global Geospatial Information Management, 2019. <https://ggim.un.org/meetings/GGIM-committee/9th-Session/documents/E_C.20_2020_10_Add_1_LAM_background.pdf>
* Current legislations

***Recommended:***

* Hassan A. Karimi: Handbook of Research on Geoinformatics. IGI, 2009. 10.4018/978-1-59140-995-3
* Eleonora Rosati: The Routledge Handbook of EU Copyright Law. Routledge, 2023. ISBN 9780367741549

**Tárgy neve:** **Geospatial algorithms L**

**Tárgyfelelős neve**: Dr. Gede Mátyás

**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 theoretical part of 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.

• Basic data structures: array, linked list, stack, queue. Priority queue, heap data structure.

• Basic algorithms: summation, counting, maximum selection, conditional variants, linear search, logarithmic search.

• Sorting: bubble sort, insertion sort, maximum sort, quicksort, merge sort, complexity analysis.

• Graph representation (adjacency matrix, edge list). Graph traversal (BFS, DFS).

• Minimum cost path graph algorithms (Dijkstra, Bellman-Ford).

• Minimum spanning trees (Red-Blue rules, Prim algorithm, Kruskal algorithm)

• Scalar indexing: binary tree, search tree, AVL-tree, B (2-3) tree

• Spatial indexing: grid index, kd-tree, adaptive kd-tree, quadtree, R-tree

• Topological algorithms: Crossing Number, Shamos-Hoey, Bentley-Ottman, Greiner-Hormann.

• Topological data structures: winged-edge, half-edge.

• Convex hull algorithms: Jarvis’s march, Graham’s scan, Quickhull, Chan’s algorithm

• Clustering and classification: K-means, ISODATA

* 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.

**Evaluation system:** oral and/or written exam.

**Literature:**

**Obligatory:**

* H. Samet: The Design and Analysis of Spatial Data Structures, Addison-Wesley, 1994, ISBN: 9780201502558
* T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein: Introduction to Algorithms, The MIT Press, 2022, ISBN 9780262046305

**Recommended:**

* 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:** 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 practical part of 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.

• Introduction to Python. Literals and variables, data types, User input management. Control structures (sequences, conditional executions, iterations). Exception handling (try & except).

• Functions: built-in functions, function definition, arguments & parameters, return value.

• Collection data structures in Python: lists, dictionaries, tuples, sets.

• Basic algorithms: summation, counting, maximum selection, conditional variants, linear search, logarithmic search.

• Sorting: bubble sort, insertion sort, maximum sort, quicksort, merge sort, complexity analysis.

• Tabular data processing (CSV, Excel files), pandas library. Plotting and diagram visualization of scalar data (matplotlib library).

• Spatial data management: vector formats (geopandas library), raster formats (rasterio library)

• Graph representation (adjacency matrix, edge list). Graph traversal (BFS, DFS).

• Minimum cost path graph algorithms (Dijkstra, Bellman-Ford). Priority queue, heap data structure.

• Minimum spanning trees (Red-Blue rules, Prim algorithm, Kruskal algorithm)

• Scalar indexing: binary tree, search tree, AVL-tree, B (2-3) tree

• Spatial indexing: grid index, kd-tree, adaptive kd-tree, quadtree, R-tree

• Topological algorithms: Crossing Number, Shamos-Hoey, Bentley-Ottman, Greiner-Hormann.

• Topological data structures: winged-edge, half-edge.

• Convex hull algorithms: Jarvis’s march, Graham’s scan, Quickhull, Chan’s algorithm

• Clustering and classification: K-means, ISODATA

* 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.

**Evaluation system:** practical course mark.

**Literature:**

**Obligatory:**

* Anany Levitin: The Design and Analysis of Algorithms, Pearson, 2012, ISBN: 978-0-13-231681-1
* T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein: Introduction to Algorithms, The MIT Press, 2022, ISBN 9780262046305

**Recommended:**

* P. Rigaux, M. O. Scholl, A. Voisard: Spatial Databases: With Application to GIS, Morgan Kaufmannn, 2001, ISBN: 9781558605886
* H. Samet: The Design and Analysis of Spatial Data Structures, Addison-Wesley, 1994, ISBN: 9780201502558

**Tárgy neve:** **Geoinformatics**

**Tárgyfelelős neve**: dr. Jung András

**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 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 vizualisation and geoinformatics modelling; geoinformatics in society, data communication; interpretation of geoinformatics data (principal component analysis, BigData, machine learning, etc.).

**Evaluation system**: oral and/or written exam.

**Literature:**

**Obligatory**:

* Gottfried Konecny. Geoinformation 2nd Edition. 2024. ISBN: 1032919531, CRC Press
* Norbert de Lange. 2024. Geoinformatics in Theory and Practice: An Integrated Approach to Geoinformation Systems, Remote Sensing and Digital Image Processing, ISBN: no data, Springer Publisher

**Recommended:**

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

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

**Tárgyfelelős neve**: dr. Albert Gáspár

**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 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.

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

**Literature:**

**Obligatory:**

* 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

**Recommended:**

* 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: Batch processing**

**Tárgyfelelős neve**: dr. Kovács Béla

**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:**

- Introduction to batch scripting

- Virtual machines

- Container technique in practice

- The base commands of Linux/Unix shell

- Sample searching (variables and greps)

- Base data processing with batch scripts in practice

- Batch scripts in extended architectures and mainframe computers

- Batch scripts in cloud data systems

- Real time data capture tasks

- Stream data processing tasks

-Microbatch and the usage of variables

- Data collection and batch scripting in data and image processing

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

**Literature:**

**Obligatory:**

1. Jack McLarney, The Book of Batch Scripting From Fundamentals to Advanced Automation, 2024, ISBN-13: 9781718503427
2. ~~Emmett Dulaney, Linux - 7 könyv 1-ben, TARAMIX Kiadó Kft., 2016, ISBN: 9786155186462~~
3. ~~Linux man-ok https://people.inf.elte.hu/csa/MAN/HTML/index.htm~~

**Recommended:**

1. Elias Bachaalany: Batchography: The Art of Batch Files Programming. PassingTheKnowledge, LLC, 2016
2. https://en.wikibooks.org/wiki/Windows\_Batch\_Scripting
3. ~~Órai segédanyagok~~

**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:**

* Aravind Shenoy: Thinking in JavaScript, Packt Publishing, 2014, ISBN: 9781783552689
* Numa Gremling? Leaflet Cookbook, Locate Press, 2019, ISBN 978-1734464368

**Recommended:**

* Lecture notes on the Canvas page of the course
* Leaflet Documentation: https://leafletjs.com/reference.html
* JavaScript Reference: http://www.java2s.com/Code/JavaScriptReference/CatalogJavaScriptReference.htm

**Tárgy neve: Project management in geoinformatics**

**Tárgyfelelős neve**: Dr. Jung András

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

**Tárgyfelelős MAB szerinti akkreditációs státusza**: AT

**Purpose of education**

1. **Knowledge**

- The students have comprehensive knowledge in the field of spatial informatics developments. Their expertise includes handling spatial data, using programming languages, and possessing software development skills.

- Additionally, they are capable of designing, developing, and operating spatial informatics systems, applying spatial data technologies in an expert manner.

- The students are prepared for industrial applications, project management, and the innovative utilization of new technologies in the field of spatial informatics.

1. **Abilities**

* The students possess extensive knowledge in spatial informatics, including efficient handling and analysis of spatial data. Moreover, through their programming and software development skills, they are capable of designing and developing spatial informatics applications.
* Their project management abilities enable effective leadership of spatial informatics projects. Thanks to their knowledge in remote sensing and a systemic approach, they can integrate various systems and solve spatial informatics problems.
* They are capable of forming independent professional opinions and keeping track of the latest trends and innovations in spatial informatics.

1. **Attitude**

* The students have a proactive and creative approach, constantly seeking new opportunities and areas for development in the field of geoinformatics. Through their collaboration skills, they effectively work in teams, contributing to the success of projects.
* They handle project management responsibly, keeping in mind business value and industrial requirements. They are open to continuous improvement and professional development.
* Their attitude reflects ethical values, user-centered design, and innovation in building spatial informatics systems.

1. **Autonomy and responsiblity**

* The students operate independently and responsibly in their projects, autonomously planning and implementing spatial informatics applications. In the field of project management, they efficiently handle time and resources.
* Through effective communication and collaboration skills, they successfully work with other professionals. They take responsibility for data protection and ethical considerations while continually enhancing their professional knowledge by keeping up with the latest technologies.
* Through the autonomous management of projects, they contribute to the efficient and effective design of spatial informatics systems.

**Content of education**

Students acquire the principles of designing and developing geoinformatics systems, including system design methods. The course explores the use of remote sensing data, the principles of project management, and emphasizes data protection and ethical considerations. The goal of the education is to prepare students for the independent planning and implementation of spatial informatics projects, as well as keeping abreast of the latest trends and developments in the field.

Fundamentals of Spatial Informatics

Geoinformatic Systems and Technologies

Spatial Informatics System Building and Design

Design and Development of Spatial Informatics Applications

Data Protection and Ethics in Spatial Informatics

Project Management in Spatial Informatics

Innovation and Future Trends

Practical Project Work

**Evaluation system:** oral and/or written exam.

**Literature:**

**Obligatory:**

* Green, K., Congalton, R. G., & Tukman, M. (2017). Imagery and GIS: best practices for extracting information from imagery (Vol. 1). Redlands, CA: Esri Press. ISBN-13: ‎978-1589484542
* Dangermond, J., & Goodchild, M. F. (2020). Building geospatial infrastructure. *Geo-Spatial Information Science*, *23*(1), 1-9. Link: <https://www.tandfonline.com/doi/full/10.1080/10095020.2019.1698274>

**Recommended:**

* GIS Analysis and Design: https://www.e-education.psu.edu/geog468/node/1405
* Breunig, Martin, et al. "Geospatial data management research: Progress and future directions." *ISPRS International Journal of Geo-Information* 9.2 (2020): 95. Link: <https://www.mdpi.com/2220-9964/9/2/95>

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

**Tárgyfelelős neve**: dr. Albert Gáspár

**Tárgyfelelős tudományos fokozata**: PhD

**Tárgyfelelős MAB szerinti akkreditációs státusza**: AT

**Purpose of education (competencies):**

**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 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.).

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

**Literature:**

**Obligatory:**

* 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.

**Recommended:**

* Kidner, D., Dorey, M., Smith, D.: What's the point? Interpolation and extrapolation with a regular grid DEM. – IV International Conference on GeoComputation, Fredericksburg, VA, USA, 1999
* Yang, C.-S., Kao, S.-P., Lee, F.-B., & Hung, P.-S. (2004). Twelve different interpolation methods: a case study of Surfer 8.0. Paper presented at the XXth ISPRS Congress Technical Commission II, Istanbul, Turkey. <http://www.isprs.org/proceedings/xxxv/congress/comm2/papers/231.pdf>
* 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: Spatial databases**

**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:**

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)

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

**Literature:**

**Obligatory:**

* PostGIS Documentation: https://postgis.net/documentation/
* Ungvári Zsuzsanna: Spatial Databases Lecture notes, 2025.

**Recommended:**

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

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

**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**

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

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

**Obligatory:**

* OpenStreetMap WIKI: https://wiki.openstreetmap.org/wiki/Main\_Page., 2020
* Ungvári Zsuzsanna: Data mining in geoinformatics, Lecture notes, 2025.

**Recommended:**

* Arsanjani, Zipf, Mooney, Helbich (eds.): OpenStreetMap in GIScience: Experiences, Research, and Applications. Springer, 2015. ISBN: 9783319142807

**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: Printing technology and bookbinding**

**Tárgyfelelős neve**: Dr. Kerkovits Krisztián

**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.

- 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.

- 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 apply what has been learned in a diverse, multidisciplinary professional environment.

**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:**

A bried history of printing from the beginnings to present days. Letterpress (relief) printing, intaglio printing, lithography and offset printing. The CTP process. Paper types, paper production, printing screens, printing inks. Map-folding, atlas binding (stitching, gluing, spiral), embroidery, ejection, use of crop marks and overstroke, direct colours. Visiting a printing company.

**Evaluation system:** oral and/or written exam.

**Literature:**

**Obligatory:**

~~Az órai előadások anyaga, ppt~~

* ~~Énekes Ferenc, A kiadványszerkesztés 2. Novella Kiadó, 2001~~

**Recommended:**

* ~~David Bann, Nyomdai megrendelők kézikönyve, Scolar Kiadó, 2007~~
* ~~Dr. Gara M., Nyomdaipari Enciklopédia, Osiris K. 2001~~

**Tárgy neve: GIS-based cartography**

**Tárgyfelelős neve:** dr. Reyes Nunez José Jesús

**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.

  -    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.

  - 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 apply what has been learned in a diverse, multidisciplinary professional environment.

**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**

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).

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

**Literature:**

**Obligatory:**

* Avenza (2020) MAPublisher 10.6: What’s new? 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: 9780470515112

**Recommended:**

* 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: 9780321934079
* Sui, D., Elwood, S. and Goodchild, M.(2013) Crowdsourcing Geographic Knowledge (VGI in theory and practice). Springer, ISBN: 9789400798267

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

**Tárgyfelelős neve**: Dr. Pál Márton

**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 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: Digital editing of derived maps**

**Tárgyfelelős neve**: dr. Ungvári Zsuzsanna

**Tárgyfelelős tudományos fokozata**: PhD

**Tárgyfelelős MAB szerinti akkreditációs státusza**: AT

**Az oktatás célja:**

**a) knowledge**

- Knowledge of methods and tools for professional and effective written, oral and networked knowledge management in cartography and geoinformatics. Ability to evaluate, use as source material and process as a database national and foreign, old and new maps and other cartographic publications (globes, sky globes, relief maps, etc.).

-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:**

1**.** Introduction to OCAD. Story of the software. Map making in OCAD, general rules.

2. Drawing and editing tools

3. Further editing tools, background maps, georeferencing maps in OCAD

4. Scales, projections in OCAD. Automated grid generation. File export, web maps

5. Symbol design: points and lines

6. Symbol design: polygons, texts, searching grid. Colors in OCAD

7. Importing data in OCAD: Shapefiles, DXF and SVG. Assign symbols to unsymbolized elements

8. Working with digital elevation models in OCAD. Hill Shading. Handling GPS data.

9. Automations in cartographic generalization

10. Editing of smaller scale maps. Map generalization.

11.Open Orienteering Mapper

12. Individual project work, map editing and design.

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

**Literature:**

**Obligatory:**

* OCAD Documentation: https://www.ocad.com/en/
* Open Orienteering Mapper: https://www.openorienteering.org/

**Recommended:**

* Terry A. Slocum, Robert B. McMaster, Fritz C. Kessler, Hugh H. Howard: Thematic Cartography and Geovisualization. Chapter 6. Scale and generalization, 10. Principles of Color, Chapter 11. Map Elements, Chapter 12. Typography, Chapter 13. Cartographic Design, 23. Visualizing Terrain. ISBN 9780367712709. Published in 2022 by CRC Press.

**Tárgy neve: Open-source WebGIS Programming**

**Tárgyfelelős neve**: dr. Gede Mátyás

**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:**

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

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

**Literature:**

**Obligatory:**

* Thomas Gratier, Paul Spencer, Erik Hazzard: OpenLayers 3: Beginner's Guide. ISBN: 9781782162360
* Gede Mátyás: The OpenLayers 5 API. https://mercator.elte.hu/~saman/edu/ol5/
* Gede Mátyás: MapServer tutorial. https://mercator.elte.hu/~saman/edu/mapserver/

**Recommended**:

* Gábor Farkas: Mastering OpenLayers 3. ISBN: 9781785281006
* Pericles S. Nacionales, Jeff McKenna: MapServer tutorial. https://www.mapserver.org/tutorial/

**Tárgy neve: Digitization and archiving**

**Tárgyfelelős neve**: Dr. Gede Mátyás

**Tárgyfelelős tudományos fokozata**: PhD

**Tárgyfelelős MAB szerinti akkreditációs státusza**: AT

**The purpose of the education:**

a) knowledge

- Comprehensively describes the task-solving principles, methods and procedures of the planning, development, and operation processes in the field of digitization and archiving, especially in the following areas: digitization, archiving, standard bibliographic description, personal and copyright law.

 Provides complex knowledge of general photographic, software management, IT and legal principles, rules, and connections necessary for working in the field of digitization and archiving, especially in the following topics: recording, image manipulation, personal and copyright law.  Enables you to create digital materials, archival documents and standard bibliographic descriptions that can be used in the fields of research, public collections, or education.

**b) abilities**

 Ability to interpret and formalize complex professional problems in the field of digitization and archiving, to reveal the necessary theoretical and practical background and to solve the problem.

 Ability to interpret, plan, organize, manage, and control processes belonging to the field of digitization and archiving.

 Ability to apply what he has learned in a diverse, multidisciplinary professional environment.

**c) attitude**

 Monitors professional and technological development in the field of digitization.

 Shares his/her own knowledge and considers it important to convey professional results.

 Committed to observing and enforcing quality requirements (accuracy, commitment).

**d) autonomy and responsibility**

 Suitable for an independent digitizer’s position, in which he conducts his tasks in a manner and at a pace set by himself, thinking through, and working out professional issues.

 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).

**Content of education:**

* The concept, purpose, and object of digitization (types of objects and documents in public collections; their systems).
* The set of digitization devices and their characteristics (scanners and cameras, color scales, lighting).
* The digital image, image manipulation (files and their properties, their manipulation procedures).
* Aspects of archival protection during digitization, archival protection problems.
* Knowledge of archiving, elements, and characteristics of the standard bibliographic description.
* Protection of personal data and copyright.

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

**Literature:**

**Obligatory**:

Elizabeth R Leggett: *Digitization and Digital Archiving - A Practical Guide for Librarians*, Rowman&Littlefield Publishers, Lanham, 2020

*Practical Guide to Emergency Digitization of Paper-based Archival Heritage.* International Council on Archives, 2023

GIMP Documentation

**Recommended:**

*Digitization Quality Management Guide*, National Archives and Records Administration, 2023

**Tárgy neve:** **CAD-based cartography**

**Tárgyfelelős neve**: Dr. Reyes Nunez José Jesús

**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 aim of the subject is to explain the options offered by CAD in map making. The topics covered during the semester are: History, general characteristics of engineering (Computer Aided Design, CAD) systems and its options and use in map making. User interface, setting and use of commands and tools. Preparation and input of printed and digital map bases. Page setup and management. Geographic coordinates in CAD systems. Drawing commands. Text editing. Edition of graphic objects. Layer management. 3D options, display of point clouds. Print and export maps. Maps on the CAD-based web. Differences and similarities in the cartographic work with CAD systems and other types of software. Organization of the map making workflow in CAD systems.

**Evaluation system**: practical task, 5 points

**Literature:**

**Obligatory**:

* Autodesk: AutoCAD Quick Start Guide. Available on <https://www.autodesk.com/learn/ondemand/curated/autocad-quick-start-guide>
* Pdf files presented by the professor with practical examples and resumes

**Recommended:**

* GIS Geography: What’s the Difference Between CAD and GIS? Available on <https://gisgeography.com/cad-gis-differences/>
* O'Donohue, Daniel (2020) GIS vs Computer-aided design – everything you have always wanted to know. Available on <https://mapscaping.com/podcast/gis-vs-computer-aided-design-everything-you-have-always-wanted-to-know-geospatial/>
* GIS People: Cartography & CAD. Available on <https://www.gispeople.com.au/category/cartography-cad/>

**Tárgy neve: GIS software (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 in detail about ESRI's geospatial solutions. In addition to the basic and theoretical knowledge of geospatial computing, the student will gain a deeper insight into the use of the software tools provided by ArcGIS. You will confidently apply these in database management, database building, mapping, spatial analysis, data mining, field survey, geospatial application development, process model building, remote sensing data processing and 3D visualisation analysis. Assessment will consist of five assignments over the semester.

Course outline:

* Practice assignments in ArcGIS Pro - a refresher of basic or prior knowledge.
* Database management and construction, the possibilities offered by ArcGIS.
* Map editing using ESRI tools. Online and analogue visualisation options.
* Geospatial, economic and social data analysis. Geostatistics in ArcGIS.
* Field survey software components.
* Applications of ArcPy in cartography.
* Analysis of remote sensing data. Artificial intelligence in ArcGIS.
* 3D capabilities of ESRI.

**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: Navigation systems**

**Tárgyfelelős neve**: dr. Kovács Béla

**Tárgyfelelős tudományos fokozata**: PhD

**Tárgyfelelős MAB szerinti akkreditációs státusza**: AT

**The aim of education:**

**a) knowledge**

- Theoretical knowledge of classic positioning and navigation systems

- Knowledge of modern navigation systems

- Theoretical and practical knowledge of general tools for navigation systems

**b) abilities**

- Ability to navigate wit classic navigation equipments

- Ability of usage of simple inertial and other IMU-s

- Ability to interpret (special) navigation maps

- Ability to navigate with the latest navigation systems

**c) attitude**

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

- Open and committed to critical feedback and evaluation based on self-reflection. Adopts and enforces with co-workers ethical principles of work and organizational culture, with particular attention to the copyright environment related to cartography and 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.

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

**Content of education:**

* Introduction, historical review
* Celestral positioning, basic of navigation, chronograph systems
* Earth based radio navigation systems (GEE, LORAN, DECCA, OMEGA etc.)
* Doppler and NNSS – from the beginnings
* LEO systems (Oscar, Transit, Tsikada, Parus etc.)
* MEO, HEO systems, inter planetary navigation systems
* NAVSTAR/GLONASS
* GALILEO/COMPASS
* Augmentation systems (EGNOS, WAAS, MTSAS, GZSS, GAGAN etc.)
* GNSS permanent stations and systems, NTRIP
* High precision positioning and navigation
* Mobile solutions
* Measurements error solutions
* Field measurement

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

**Literature:**

**Obligatory**

* 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

**Recommended**

* Laurie Tetley etal: Electronic Navigation Systems, Taylor & Francis, 2012, ISBN: 978-0-7506-

5138-7

**Tárgy neve: Spatial process model building**

**Tárgyfelelős neve:** dr. Gede Mátyás

**Tárgyfelelős tudományos fokozata:** 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>

**Tárgy neve: Internship (3 weeks)**

**Tárgyfelelős neve:** dr. Zentai László

**Tárgyfelelős tudományos fokozata:** DSc

**Tárgyfelelős MAB szerinti akkreditációs státusza:** AT

**Purpose of education**

1. **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.

- 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 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) atitude**

- Open and committed to critical feedback and evaluation based on self-reflection. Adopts and enforces with co-workers ethical principles of work and organizational culture, with particular attention to the copyright environment related to cartography and geoinformatics.

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

- It attaches importance to the promotion and implementation of environmental awareness and sustainable development, and promotes this through the tools of cartography and geoinformatics.

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:**

Summer internship in a company/institution with the primary aim of gaining work experience. Depending on the student's interest and the companies/institutions willing to host them, the tasks may vary: national mapping agency, GIS company, higher education institution.

Previous work experience may be recognised. If there is sufficient receptivity, the internship can be carried out in the student's home (national) institution/company (with the prior agreement of our institution).

Hungarian companies/institutions are most willing to host foreign students in the fields of remote sensing and geoinformatics.

**Evaluation system**: practical work based in course work

**Literature:**

**Obligatory:**

* QGIS offical Documentation: https://www.qgis.org/en/docs/index.html

**Recommended:**

* Direction for use of instruments and tools
* Official Documentation of other GIS software

**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

**Literature**

**Obligatory:**

* All written material of the topic of the thesis

**Recommended:**

* All written material of the topic of the thesis

**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: Erasmus mobilitás – térképészeti blokk**

**Tárgyfelelős neve**: Prof. dr. Zentai László

**Tárgyfelelős tudományos fokozata**: DSc

**Tárgyfelelős MAB szerinti akkreditációs státusza**: AT

**Erasmus mobility – cartography courses**

**Purpose of education:**

a, knowledge

- the professional knowledge described in cartography 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 cartography 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