Geoinformatics MSc Final Exam Topics

Valid from 2025

Exam procedure: The student draws one topic from List "A". From List "B", the student first selects five topics and then draws one from those.

List "A":

1. Spatial Reference Systems:

Present the horizontal (projected, spherical, ellipsoidal, astronomical) and vertical coordinate systems used in terrestrial positioning, and the possible methods for coordinate transformations. Discuss the concepts and main types of horizontal and vertical datums, the types of distortions of map projections used for planar coordinate systems, the classification of projections (e.g., by the shape of the graticule or by distortion), and the criteria for choosing a map projection. Provide examples of reference frames and projections used in national and international coordinate systems. Explain how coordinate systems can be set or changed in major GIS software environments.

2. Geostatistics and Geomathematics:

Define geomathematics and geostatistics, and outline how these deal with spatial phenomena and what questions they answer. Make a distinction between stochastic and deterministic approaches in spatial modelling. Compare geostatistics to mathematical statistics, highlighting the role of spatial dependence. Define the variogram and summarise its key attributes. Position common deterministic interpolators—IDW and nearest-neighbour—in relation to geostatistical interpolation. Define Voronoi (Thiessen) diagrams. Close by sketching how a coherent workflow might combine these ideas to choose an interpolation/analysis strategy consistent with data characteristics and decision needs.

3. Data Mining and Spatial Databases:

Define the concepts of data mining and big data. Illustrate with examples how data mining is applied in GIS. Discuss possible input data types, applicable tools, and the spatial data formats into which data can be processed. Explain basic database management concepts and describe a spatial database management system and its characteristics. How does such a system handle vector data? Describe some geoprocessing and geometry functions. Explain how data mining and spatial databases are connected.

4. Algorithms in Geoinformatics:

Describe the graph data structure: basic concepts, representation forms, and traversal methods. Explain how it relates to geoinformatics. What are the possible applications of graph data structures (e.g., in network modelling)? Present routing problems in spatial networks, including shortest or minimum-cost paths and spanning trees, and the classical algorithms used to solve such problems. Define and explain spatial indexing. Describe the

algorithms for convex hull, bounding rectangle, minimum bounding rectangle, and clustering procedures.

5. Remote Sensing:

Define the field of remote sensing and describe its general principles. Explain how the sensor–platform–data chain is linked and how it integrates into the geoinformatics processing workflow. Present the resolution parameters characteristic of different remote sensing systems and how these affect data applicability. Define passive and active remote sensing, describe their instruments, operating principles, and data characteristics. List major Earth observation satellite systems and their typical resolutions. Explain radiometric and geometric corrections. Discuss the roles of classification and segmentation in image processing. Present some commonly used remote sensing indices.

6. Measurement and Data Collection Methods:

Describe the main instruments used in field data collection and high-precision surveying, with particular focus on GNSS, stereophotogrammetry, geodetic methods allowing sub-centimetre accuracy, and terrestrial, airborne, and satellite remote sensing. Explain the operating principles of these instruments and methods. Highlight the main sources of measurement error, environmental requirements (e.g., weather), accuracy limitations, and main fields of application. Address current legal obligations where relevant (e.g., drone usage regulations).

7. Vector GIS: Spatial Relations and Geometric Operations:

Present the theoretical background of vector systems and give an overview of major types of vector analysis operations with practical examples. Characterise the topological data model and explain why it is advantageous for organising spatial data. Describe the structure and characteristics of typical desktop and server-based GIS systems. What file and database formats are characteristic of vector GIS? Present the TIN model and discuss the properties of point clouds and meshes.

8. WebGIS:

Describe the architecture of server–client WebGIS applications, including the roles of the server and the client side. What are the advantages and limitations of purely client-side applications? What external online services are commonly used in WebGIS? Explain the role of HTML, CSS, and JavaScript, and how they relate to WebGIS solutions. Describe the operational background of ESRI's server-based applications.

9. Map Design and Cartographic Editing:

Present the main principles of cartographic design. What are the typical characteristics of a map model or maquette? Describe the main components of a map legend. What does it mean to create a balanced legend, and why is it important? How does a thematic legend differ from this, and in what cases is it necessary? Describe the main categories of general-purpose maps and highlight the differences between their legends. Using a general geographic map as an example, outline the key steps of map compilation and design.

10. Digital Terrain Models:

Define digital terrain models (DTMs), describe their typical data structures and data acquisition methods. Explain the purpose of spatial interpolation, list common interpolation techniques, their principles, advantages, and disadvantages. Present the most important DTM databases (data sources, coverage, resolution, typical errors). What visualisation options exist for DTMs? What derivative maps can be generated from DTMs, and what are their principles (e.g., slope maps, filters)?

List “B”:

1. Socioeconomic Databases:

What are the main sources of socioeconomic data? What should be the fundamental principles to follow when selecting online socioeconomic databases? Can you give specific examples of socio-economic databases that can be found on the web? How can we visualise quantitative data, and how can qualitative data be represented? How can data visualised using different applications be presented in an integrated manner online (e.g. on a dynamic and interactive web page)?

2. Spatial Process Modelling and Plugin Development in GIS:

Present the most important principles of spatial process design and automation in GIS. Highlight the role of model-based solutions (ArcGIS ModelBuilder, QGIS Graphical Modeler, or FME Workbench) in workflow design. Compare them with scripting-based and plugin extensions providing custom functionality in GIS environments. Describe the architecture and development cycle of GIS plugins or extensions and discuss how they work with GIS components and various data sources. Provide examples of hybrid workflows where process models and scripts work together. Discuss the importance of version control, documentation, parameterisation, and interoperability.

3. Geoinformatics in Environmental Protection and Systems:

Describe the role of GIS in analysing and managing environmental systems and human-induced disturbances in the Earth system. Present the main environmental datasets and monitoring networks used for assessing air, water, and soil quality. Explain how geoinformatics supports the detection, modelling, and mitigation of environmental problems. Discuss the principles of system theory in environmental modelling, including feedback mechanisms and material fluxes. Highlight the integration of satellite-based and in-situ observations in environmental monitoring, and outline GIS approaches to risk assessment and sustainable environmental management.

4. Dedicated Geospatial Information Systems:

What are dedicated geospatial information systems, and how do they differ from other information systems? Choose one domain-specific system and describe the typical databases, data models, analytical, and visualisation tools it uses.

5. Modern Geodesy and Topography:

Outline the role of geodesy and topography in map production and the creation of map databases. List and briefly describe the types and instruments of geodetic measurements and modern data acquisition and topographic surveying methods. Enumerate and briefly describe the technological steps and requirements of building digital topographic map databases.

6. Geovisualization:

Describe the main cognitive processes of geovisualization (perception, visual information processing in the brain, spatial orientation and memory, and cognitive maps). Outline the

goals and methods of user-oriented cognitive research in cartography and GIS (eye-tracking, brain imaging, and empirical behavioural studies). Illustrate with examples how such research results are applied in GIS (design of graphical interfaces and interactions: horizontal and vertical image organisation, Gestalt principles, semiotics, narrative structures, and affordances).

7. Thematic Data Visualisation:

Describe the main cartographic thematic data representation methods and specify which are applicable in GIS environments. Differentiate the main data type groups, present their classification methods, and explain how these can be transformed into cartographic–GIS visualisations. Present several modern GIS-based thematic visualisation methods and tools.

8. 3D Modelling in Geoinformatics:

Using an example of modelling that employs multiple data types and complex spatial datasets, describe possible steps and infrastructure for data preparation. Present the operations performed, including error calculation, through the example of generating and intersecting model surfaces derived from data at two different scales. Characterise spatial and temporal (2.5D, 3D, 4D) analyses and the modelling methods applied to them.

9. UAV-Based Geoinformatics and Sensor Integration:

Explain the role of unmanned aerial vehicles (UAVs) and sensor systems in GIS. Describe the main types of UAV platforms and the sensors they can carry, and discuss their spatial, spectral, and temporal characteristics. Present the typical workflow of UAV-based data acquisition. Outline the integration of UAV data with other spatial datasets (e.g. satellite imagery, GNSS measurements, digital terrain models). Discuss key applications such as precision agriculture, environmental monitoring, disaster management, and 3D surface reconstruction. Highlight the advantages and limitations of UAV-based sensing in terms of accuracy, resolution, legal regulations, and data processing requirements.

10. Geoinformatics Programming:

Describe possibilities for automating spatial data analysis, from batch data processing to graphical model building and script development. Explain the basic principles of plugins in GIS software. Describe the tools, workflow, and practical implementation of plugin development. Discuss scripting in GIS environments. Present commonly used image processing algorithms in geoinformatics in the following areas: line vectorisation, pattern recognition, and OCR.