Kraków 11.10.2022

General topics applicable* to the engineering examination for the first degree course in Geoinformatics and for the entrance examination for the second level of education in the field of Geospatial Computer Science Faculty of Geo-Data Science, Geodesy, and Environmental Engineering

from the academic year 2022/2023

Spatial analyses in a raster model

1. Raster analyses using local functions.
2. Raster analyses using neighbourhood functions.
3. Raster analyses using zonal functions.
4. Raster analyses using global functions.
5. Basics of multi-criteria analysis - overlay method (logic maps), weighted linear combination method.

Spatial analyses in a vector model

1. Basic spatial analysis in a vector model (selection, caching, layer overlay, statistics, reports, graphs).
2. Automation of spatial data processing and analysis (analysis models, Python language - scripts, use in field calculator).
3. Vector terrain surface models (building and basic analysis).
4. Geocoding and network analysis (routing).
5. Data sources for spatial analyses in the vector model (State Geodetic and Cartographic Resource, OpenStreetMap).

Photogrammetry

1. Orthophotomap - stages of creation, possible use.
2. Numerical terrain model - methods of creation, how to use.
3. Photogrammetric methods and laser scanning in modelling environmental elements.

Spatial information infrastructure

1. Formal and legal bases for the functioning of SDI in Poland.
2. Registers complementary to database of topographical objects.
3. Definition and characteristics of the Database. Topographic Objects at different scale levels.
4. Definition and characteristics of standard mapping studies.

5. Definition and characteristics of metadata in SDI public registers.
6. Standards and formats for data exchange in SDI public registers.

Environmental research and analysis methodology

1. Definitions of the limit, target and long-term objective levels of substances in the air.
2. Criteria for assessing air quality in Poland (including substances for which limit or target levels in the air are set for health and plant protection reasons and the averaging times used).
3. General methods used to assess air quality (including those forming the basis of current air quality assessments) and their characteristics.
4. Sampling techniques used in the measurement of air pollutant concentrations by manual (aspiration, isolation, passive) and automatic methods - characteristics.
5. Reference methods used for measuring air concentrations of key pollutants - names of measurement techniques and their classification (automatic/manual measurements, type of substance).
6. Methods for the determination of soil pH and of the density of essential plant nutrients (N, P and K). The concept of a soil sample. Forms of water in soil. Fractions of organic matter in water. Methods of determining organic matter in water. Methods of assessing the quality of flowing waters. The Water Framework Directive.
7. Structure of the State Environmental Monitoring.

Cartographic modelling and geovisualisation

1. Definition and characteristics of the Digital Landscape Model.
2. Definition and characteristics of the Digital Cartographic Model.
3. Definition and characteristics of model and cartographic generalisation.
4. National maps and thematic databases.
5. Definition and characteristics of qualitative cartographic visualisation methods.
6. Definition and characteristics of quantitative cartographic visualisation methods.

Non-parametric modelling of 3D objects

1. Parametric and non-parametric modelling.
2. Types of objects modelled.
3. Single and multi-equation models.
4. Quadrics (second degree surfaces).
5. Glued functions.
6. Mesh nets.

Fundamentals of geostatistics and artificial intelligence methods

1. Analysis of spatial variability using geostatistical tools.
2. Solving kriging equations.
3. Applications of neural networks.
4. The process of training networks and building models based on neural networks.

Fundamentals of civil engineering

1. Building law requirements for the scope and content of the technical design of a building.
2. Aspects of structural safety in building design: strength, stability, stiffness, load-bearing capacity. Limit states considered at the design stage. Insulation and fire protection requirements for building partitions.
3. Explain the term "building foundation"; how its thickness is determined. Material and geometric aspects and how building structures are loaded in determining the load carrying capacity of structural elements. Classify the types of loading adopted in the design process of building structures.
4. The concept and structural solutions of timber-framed buildings.
5. Classification of direct foundations, their characteristics and use. Gradation by stiffness. Method of load transfer. Bearing capacity of the building foundation. Characteristics of indirect foundations. Method of load transfer. Types.
6. Classification of reinforced concrete floors with a distinction between slab, slab-rib, dense-rib floors, advantages and disadvantages.

Fundamentals of computational and numerical methods

1. Interpolation and approximation methods.
2. Methods for solving systems of linear and non-linear equations.
3. Numerical integration methods.

Fundamentals of Earth Sciences I

1. Age of the Earth. Structure of the Earth's crust, types of crust (thickness, formation) Earth's radius, movement of continents, plate tectonics (subduction and spreading zones, phenomena at plate boundaries). Geological endogenic and exogenic processes, their role in shaping rocks and minerals and tectonic formations and terrain morphology. Plutonism and volcanism, post-volcanic phenomena. Diastrophism. Forms of fluvial and glacial erosion and accumulation. Division of rocks /genesis/ (examples). Mass movements (mainly landslides) division, hazards. Groundwater reservoirs, groundwater bodies, free water table, pressure and piezometric water table. Porosity of rocks, permeability (definitions), reservoir properties. Range of most common porosities for sand, gravel, sandstone, clay, siltstone, clay, granite, limestone.
2. Stratigraphic table of names and order: Palaeozoic and Mesozoic era - periods, Cenozoic era - periods and epochs. Basic terms and methods of stratigraphy. Basic parameters of a geological layer, actual and apparent thickness, fall, run. Recognition on a simple geological map of structures: anticline, monocline, syncline, vertical fault, horizontal fault.
3. Definition and examples of different forms of relief. Elements of terrain relief - their types, divisions and characteristics. Numerical indicators of terrain relief characteristics.
4. Soil-forming factors, basic soil-forming processes. Structure of the soil profile, genetic levels. Soil as a three-phase system. Characteristics of the solid phase of soil - grain size, bulk density, specific density, porosity. Types of soil water. Systematics of soils according to PTG. Types of soil maps, soil mapping work, laboratory tests and camera work.

Fundamentals of Earth Sciences II

1. States of matter of water and phase transitions.
2. Hydrological cycle, water balance, hydrological processes.
3. Aquatic ecosystems. Basic geographical and hydrological knowledge of: oceans, seas, lakes, rivers, springs.

4. Characteristics of the atmosphere (atmospheric pressure, homosphere, ozonosphere, thermal structure of the atmosphere, dryadiabatic temperature gradient).
5. Basic concepts of meteorology (types of radiation, solar constant, advection, convection, convergence, divergence, equilibrium state of the atmosphere, temperature inversion, albedo, types of winds, vertical circulation model of air masses).
6. Effects of natural and anthropogenic atmospheric pollution (acid smog, photochemical smog, greenhouse effect, climate change).

Fundamentals of spatial information systems

1. Graphical representation of spatial data (vector model vs. raster model; advantages, disadvantages, differences, applications).
2. Attribute-spatial analyses. 3. 3. raster analyses (using attribute queries, map algebra, basic neighbourhood and distance operators).

Processing of environmental data

1. Methods for assessing the risk of water erosion to soils - USLE model.
2. Methods for assessing surface water quality.
3. Interpretation and quality assessment of measurement data from the air quality monitoring system.
4. The 'openair' package and its applications.

Spatial reference systems

1. Calculations (length, azimuth, area) on a reference surface (plane, sphere, ellipsoid). Characteristics of coordinate systems on the plane, sphere and ellipsoid, calculation of coordinates in systems. Mappings of the sphere and ellipsoid to the plane, properties of mappings. Properties of Cartesian coordinate transformations. Horizontal reference systems and coordinate systems - properties of systems, differences between reference systems. Height systems - properties of systems, differences between height systems.
2. State Spatial Reference System - geodetic matrices defining datums and elevation systems.

CAD techniques

1. Main CAD packages
2. Drawing file formats in the main CAD packages
3. Tools for creating basic drawing elements (2D)
4. Tools for modifying basic drawing elements (2D)
5. Ways of extracting textual information from a drawing
6. Local coordinate systems
7. Model and paper area

BIM technology

1. Content, structure and construction of openBIM files and diagrams: IFC, BCF, IDS, IDM, bsDD
2. Structure and use of a shared data environment as defined by ISO 19650.

3. Design and investment process - modelling in BPMN notation.
4. Applying machine learning methods to the analysis of digital spatial and construction data.
5. Integration of BIM and GIS technology
6. Cross-industry coordination
7. Formal documentation of the BIM process: EIR, BEP
8. Information models and their application: PIR, AIR
9. Information requirements - scope and content: PIR, OIR
10. Open GIS data for BIM processes: applications, opportunities, limitations and processing algorithms
11. Digital data processing, algorithmic design, algorithms

Technologies for the extraction of spatial data

1. Surveying instruments used for spatial data acquisition (e.g. levellers, total stations, satellite receivers, laser scanners) - construction, principle of operation, instrumental errors, necessary accessories.
2. Methods of situational and elevation measurements used for spatial data acquisition - principles of making and processing observations, accuracy of data acquired.
3. Characteristics of spatial data extracted by geodetic methods.
4. Standards and formats for the exchange of data acquired by different measurement methods.
5. Field test procedures for surveying instruments to assess measurement accuracy.

Remote sensing with elements of digital signal processing

1. Availability of images from multispectral and radar sensors.
2. Vegetation indicators in the study of environmental change.
3. Processing of multispectral images (preprocessing, classification, assessment of classification accuracy).
4. Radar image processing.

Environmental information resources

1. INSPIRE Directive - thematic scope of the planned resource layers, goals, objectives. Publicly available environmental information resources in Poland (geology, nature, environmental quality, spatial planning) examples: location and thematic scope. Access to environmental information rights of citizens and restrictions on access.
2. Information resources on soils and habitats, forests, surface and groundwater, geological resources, meteorological data - available sources and principles for obtaining information.
3. Structure of the State Environmental Monitoring, information available on the Provincial Environmental Inspectorate web portals.
4. Environmental information resources at EU and global level - examples of data sources. Topics, specificities, access to information. Including: the European Soil and Habitat Information Systems (EUSIS - The European Soil Information System).
5. Definitions and examples: entities, metadata, 'big data', spatial data.

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(*) In accordance with the regulations in force on the day of the examination, unless otherwise stated in the text of the question.