**Faculty of
Environmental Sciences**

Final State Examinations for Bachelor Programmes – Thematic Areas

2022

Environmental Data Science

Earth System Science

1. Which are the three system types concerning mass and energy transport? Give a brief description and an example for each one of them. What is the difference between conduction and convection? What is entropy? Give an example that demonstrates how entropy reaches equilibrium.
2. Which types of radiation affect the climate of Earth? How? What happens with energy from electromagnetic radiation when wavelength becomes longer? Gamma or infrared rays have higher radiation?
3. What is the difference between heat and temperature? Which atmospheric layer has greater mass? Why does the thermosphere have lower heat content than troposphere?
4. How does saturation pressure affect system capacity to hold water vapor? Why is it possible for dry air in a desert to contain more water vapor than moist air in the Arctic?
5. Describe the relationship between Hadley cells and the intertropical convergence zone. Where are the deserts located on the world map? Describe the reason in regards with atmospheric circulation.
6. Describe the greenhouse effect. Is it related to shortwave or longwave radiation? Is the term "greenhouse effect" representative according to the processes involved in the heat transfer? Why (not)?
7. What are the layers of the earth and what are they composed of? What causes the Moho discontinuity? What is a seismic wave? P waves or S waves more damaging? Why?
8. Which are the main drivers of oceanic circulation? What is the difference between them? Describe the process of thermohaline circulation and its climate effects on northern Europe? Which factors cause ocean water to be vertically stratified?
9. Describe the Coriolis force. What causes Coriolis force and how it is related to Ekman spiral? Describe how North Atlantic Water is produced and explain its role in the global ocean conveyor system. What is El Nino and how is it connected to oceanic circulation?
10. Which are the three most important biogeochemical cycles? Briefly describe them. What is the difference between autotrophs and heterotrophs? Why is the process of photosynthesis critical for life over land? Which kind of radiation is photosynthesis related to (long or short)?
11. What is an ecosystem and what is a biome? How is the distribution of biomes related to climate? What is biological productivity? What is the difference between gross productivity and net productivity?

Literature

- Skinner BJ, Murck B. The blue planet: an introduction to earth system science. 2011
- Fleurant C, Bodin-Fleurant S. Mathematics for Earth Science and Geography. Springer; 2019

Environmental Data Analysis

1. Mean, standard deviation, skewness. Difference between the mean and the median.
2. Definition of exploratory data analysis and its main components. Expected outcome.
3. What is analysis hypothesis? What are summary statistics? Why do we use them?
4. Data visualization – components of the figure, position scales, color scales, faceting and best practices.
5. Data types – name the types of data with examples from the environmental sciences. What are the typical sources of data, examples from environmental sciences and their base characteristics? What is their representation in various programming/scripting languages?
6. Visual tools for summarizing data – histograms, boxplots, ecdf. Types of graphs for 1-, 2- and 3-D data.
7. Tidy data, wide and long tables. Joining the data, types of joins.
8. Give some examples of common data transformations? What are the quantiles and how can they be used for data discretization/classification?
9. Graphical and numerical description of dependence.
10. Statistical Regression: Linear, polynomial, and loess models.

Literature

- M. Çentikaya-Rundel and J. Hardin, Introduction to Modern Statistics, Openintro, 2021
- Ronald K. Pearson, Exploratory Data Analysis Using R, Routledge, 2018
- Alen B. Downey, Think Stats: Probability and Statistics for Programmers, 2014

Hydrology

1. Hydrological cycle, hydrological system, dynamics of hydrological system, scale in hydrology
2. Budyko curve, Regional hydrological balance, hydrological production, watershed, geomorphological characteristics of watershed, selected algorithms for processing DEM
3. Hydrological data, hydrological process, hydrological variable, hydrological series, aggregation and disaggregation of hydrological series, autocorrelation function of hydrological series, introduction into the decomposition of hydrological time series
4. The basic processing of hydrological time series, statistical properties of hydrological dataset, quantile estimation, hydrological extremes, return period, introduction into the linear model and its application in hydrology
5. Precipitation, rainfall depth, rainfall intensity, meteorology of precipitation, convective and stratiform rainfall events, precipitation monitoring, estimation of missing rainfall data, interpolation methods of rainfall point measurement, mean areal precipitation,
6. Processing precipitation data for hydrological design purposes, probable maximum precipitation, IDF curves, DDF - depth duration frequency curves - maximum, design hyetographs
7. Runoff, river discharge, hydrograph, flood hydrograph, N-year discharge, FDC curves, clasification runoff processes, Hortonian runoff, runoff from variable source area, subsurface runoff, transformation of flood hydrograph by the river reach, transformation of flood hydrograph by the reservoir, runoff monitoring, stage-discharge relationship
8. Evaporation evapotraspiration, potential and actual evapotranspiration, interception, introduction into the snow hydrology, snow measurement, characteristics of snow cover, space-time dynamics of snow cover, melting, snowmelt model, day degree model
9. Unsaturated zone, dynamics of unsaturated zone, soil water content, retention curve, Darcy Buckingham law,
10. Groundwater, Darcy law, groundwater regimes, aquifer, isolator, master recession curve

Literature

- Dingman, S.L. (2002) Physical Hydrology. 2nd Edition, Prentice Hall, Upper Saddle River, 646 p.
- Viessman, Warren, and Gary L. Lewis. Introduction to Hydrology. Upper Saddle River, NJ: Prentice Hall, 2003 (or another edition)

Ecology

1. Briefly explain the organization of a food chain
2. Explain some examples of mechanical defenses or adaptations of species to discourage animal predation
3. Which adaptations have mammals to be protected against extreme temperatures (high or low)?
4. Explain the ecological role of pollinator species
5. What is the difference between a population and a community?
6. Are all individuals of the same species identical? Use ants as an example.
7. Explain the main focus of "Ecology" and the potential overlap with other scientific disciplines
8. What is the interspecific competition (cite an example)
9. Are two species distributed in the same territory sharing the same "ecological niche"?
10. What is a parasite species? (cite one example)
11. What is a "bioindicator"?
12. Describe at least three interspecific relationships
13. Is evolution a linear process?

Literature

- Begon, M.E., Townsend, C.R., Harper, J.L., 2006. Ecology: From Individuals to Ecosystems, 4th Edition, John Wiley & Sons, Ltd, Oxford.

- Gaston K.J., 1996 Biodiversity a biology of numbers and difference. Blackwell Science, Oxford etc., 396 pp.

- Krebs C.J., 1998 Ecological methodology, 2nd edition. Addison Wesley Longman, Menlo Park etc., xii+620 pp.

Informatics

1. JavaScript: Fitting into the WWW environment, language characteristics, standardization, JavaScript vs. TypeScript
2. JavaScript: Client to server communication, frameworks, development process and tools, libraries and package managers, Node.js
3. Markup Languages: purpose, usage. XML, XML data validation, XML Schema, XSLT, XQuery, XPath.
4. Data formats, JSON, CSV, Syntax of XML and HTML, HTML semantics, metadata.
5. Systems and application on the WWW platform, principles, functions, management. Client to server-side communication.
6. Web browsers, DOM, client-side data storage, server-less platforms, database systems.
7. HTML - versions, standardization, language syntax, semantics. Scripting and programming languages for WWW, client-side/server-side technologies.
8. CSS - language syntax, standardization, layout. Supporting mobile devices, mobile-first. CSS methodologies, preprocessors.
9. Algorithm properties. Structured algorithm design. Depiction of algorithms using planar structograms.
10. Flow control structures. If/else/else if conditional statements. Branching program flow using the switch statement. While and do-while loop statements.
11. Modular programming. Functions and function parameters. Return value of a function. Recursion. Variables and their memory representation. Pointers.
12. Prepositional logic. Preposition. Logic variable. Logic conjunctives and examples of their use. Logic formulas.
13. Interpreted vs. compiled programming language. Platform portability. Dynamic typing. Python packages, pip. Python environments, virtual environments, conda.
14. Python collections, indexing, slicing. Collection manipulation (for-in loop, filter, map). Numpy, Pandas, DataFrame.

Literature

- Flanagan, D. (2020). JavaScript: The definitive guide: Master the world's most-used programming language. O'Reilly Media, Incorporated.
- Frain, B. (2020). Responsive Web Design with HTML5 and CSS: Develop future-proof responsive websites using the latest HTML5 and CSS techniques, 3rd Edition. Packt Publishing.
- Dykes, L., & Tittel, E. (2005). XML For Dummies (4th ed.). For Dummies.
- Beazley, D., Jones, B. K. (2013) Python Cookbook. O'Reilly Media. ISBN 978-1449340377
- JOHNSON, Bruce. Professional Visual Studio 2017. Indianapolis, Indiana: Wrox, a Wiley brand, 2017. ISBN: 9781119404583

- Knuth, D. E. The art of computer programming. Vol. I, Fundamental Algorithms. 3rd ed. Reading, Mass. Addison-Wesley, 1997. ISBN 0-201-89683-4.
- Knuth, D. E. The art of computer programming. Vol. II, Seminumerical Algorithms. 3rd ed. Reading, Mass.: Addison-Wesley, 1997. ISBN 0-201-89684-2.
- Knuth, D. E. The art of computer programming. Vol III, Sorting and Searching. 3rd ed. Reading, Mass.: Addison-Wesley, 1997. ISBN 0-201-89685-0.