Syllabus
«Fractal Models in Data Analysis»

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Expected learning outcomes
As a result of studying the discipline, the student
must know:

- concepts of fractals, monofractals, multifractals;
- main properties and differences of mathematical and physical fractals, definition and classification of fractal dimensions;
- examples of fractals in mathematics and the surrounding world;
- properties and examples of multifractals;
- concept of fractal models;
- basics of fractal analysis of data from different areas;
- examples, results and interpretation of the results of fractal and multifractal analysis of real processes.

must be able to:

- build basic fractal models for solving applied problems;
- adapt basic fractal models to solve various problems in different subject areas;
- calculate fractal dimensions of model fractal objects;
- conduct fractal and multifractal analyzes of real data arrays, using the capabilities of computer mathematics systems.

The scope of the discipline: 5 ECTS credits (16 hours of lectures, 48 hours of practice).

Purpose: formation of students' theoretical knowledge about fractal models, modern methods of fractal and multifractal data analysis, as well as their use for solving practical problems, and acquisition of skills for their effective use. The practical part of the course is aimed at considering the actual issues of using modern information technologies to solve intellectual problems using fractal models to solve various problems, in particular, to study the growth of clusters, cities, websites, in linguistics, business and financial data, etc.

The content of the discipline

Topic 1. Fractal concept in data analysis. Fractality of natural phenomena.
Topic 2. Creating the theory of fractals.
Topic 3. Monofractals
Topic 4. Multifractals.
Topic 5. Examples of fractals.
Topic 6. Construction of fractal models.
Topic 7. Fractal models of natural objects.
Topic 8. Fractal modeling of physical processes.
Topic 9. Percolation of fractal objects and its mathematical description.
Topic 10. Examples of the application of the concept of fractals in the natural sciences.
Topic 11. Fractal models in economic and sociological sciences.

Prerequisites
"Higher mathematics", "Theory of algorithms", "Probability theory, probabilistic processes and mathematical statistics", "Mathematical methods of intelligent calculations".

Consequences
The knowledge gained during the discipline can be used in the disciplines or areas "Intelligent decision support systems", "Software intelligent control systems", "Methods of computational intelligence".

Technical support
Practices on the discipline are carried out in computer classes using Microsoft Visual Studio, Java SE, Python, C#.

Deadline policy
Works that are submitted in violation of deadlines without good reason are evaluated at a lower grade.

Academic Integrity Policy
Provides independent performance of practices. Write-off (including using mobile devices) is prohibited. The work is not credited in case of detection of plagiarism or write-off.

Evaluation criteria of laboratory works / practices / individual works / reports / projects

Maximum number of points – a student with high quality independently performed the entire scope of work, answers all questions related to the work performed, and does additional tasks, for example, correctly applied a certain fractal model offered to him by the teacher. The teacher has no complaints about the software implementation and performance requirements.
Approximately 70%-99% of the maximum number of points – a student with sufficient quality independently completed all tasks, but in the process he made some mistakes, which, after pointing to them by the teacher, corrected themselves. He answers some questions with a slight error. The additional calculations offered by the teacher make with some complexity. Not all work requirements are met.
Approximately 40%-69% of the maximum number of points – a student of average quality independently completed all tasks, but did not meet all the requirements for implementation. He answers the question with a slight error. The additional calculations offered by the teacher, for example, the application of a certain fractal model for data analysis makes with insignificant errors. Not all requirements for the design of the work are met.
Approximately 1%-39% of the maximum number of points – a student performed all the work independently, but the quality of implementation is insufficient (errors in calculations, not all work requirements are met). The answers to the questions about the work are not entirely clear. There are errors in the answers.
0 points – a student did not perform the entire amount of work, or performed with gross errors. He has problems with calculations by certain models, does not know the theoretical material, the software implementation does not meet the requirements.