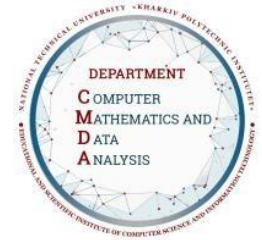




## Syllabus Course Program



# DATA AND TIME SERIES ANALYSIS

### Specialty

113 Applied mathematics

### Educational program

Intelligent data analysis

### Level of education

Bachelor's level

### Semester

6

### Institute

Educational and Scientific Institute of Computer Sciences and Information Technologies

### Department

Computer Mathematics and Data Analysis

### Course type

Special (professional), Mandatory

### Language of instruction

Ukrainian

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## Lecturers and course developers



### First name and surname

Sergey Garder [Sergei.Garder@khpi.edu.ua](mailto:Sergei.Garder@khpi.edu.ua)

Candidate of technical sciences, associate professor of the department of computer mathematics and data analysis of NTU "KhPI".

Work experience – 32 years. Author of 89 scientific and educational and methodological works. Leading lecturer in the disciplines: "Data analysis", "Theory of time series", "Artificial neural networks"

Learn more about the teacher on the department's website

## General information

### Summary

The purpose of teaching the discipline is to provide training for specialists in the field of applied mathematics who are able to formulate, solve and generalize practical problems in their professional activities using fundamental and special applied methods of data and time series analysis, develop mathematical models, algorithms, create and operate appropriate software software..

### Course objectives and goals

The purpose of teaching the discipline is to provide training for specialists in the field of applied mathematics who are able to formulate, solve and generalize practical problems in their professional activities using fundamental and special applied methods of data and time series analysis, develop mathematical models, algorithms, create and operate appropriate software software.

### Format of classes

Lectures, laboratory classes, consultations, self-study. Final control in the form of an exam.

### Competencies

GC 1. Ability to learn and master modern knowledge.

GC 2. Ability to apply knowledge in practical situations.

GC 3. Ability to generate new ideas (creativity).

GC 6. Capability of abstract thinking, analysis and synthesis.

SC 3. Ability to choose and apply mathematical methods for solving applied problems, modelling, analysis, design, management, forecasting, decision-making.

## Learning outcomes

LO 1. Demonstrate knowledge and understanding of basic concepts, principles, theories of applied mathematics and use them on practice.

LO 2. To know the basic principles and methods of mathematical, complex and functional analysis, linear algebra and theory numbers, analytic geometry, theory of differential equations, in particular partial differential equations, probability theory, mathematical statistics and random processes, and numerical methods.

LO 3. Formalize tasks formulated in the language of a particular subject fields; formulate their mathematical formulation and choose rational method of solution; solve the resulting problems with analytical and numerical methods, evaluate the accuracy and reliability of the results obtained.

LO 14. Demonstrate the ability to self-learn and continue professional development.

LO 24. Be able to apply existing and develop new algorithms and software tools for processing measurement and observation data, texts, signals and images.

## Student workload

The total volume of the course is 120 hours (4 ECTS credits): lectures – 30 hours, practical classes – 30 hours, self-study – 60 hours.

## Course prerequisites

To successfully complete the course, you must have knowledge and practical skills in the following disciplines: "Linear Algebra", "Mathematical Statistics"..

## Features of the course, teaching and learning methods, and technologies

When teaching the discipline "Analysis of data and time series", it is envisaged to use active and interactive teaching methods: lectures, collective discussion of problems in an active form, practical classes. The effectiveness of the educational process is manifested in the increase of self-awareness of students; formation of the ability to make independent decisions, acquisition of skills for collective discussion of problems; development of analytical and logical abilities. Study materials are available to students through Teams.

## Program of the course

### Topics of the lectures

Topic 1. Multivariate dispersion analysis.

1.1. Two-factor variance analysis.

1.2. Three-factor variance analysis.

Topic 2. Regression analysis.

2.1. Pairwise regression; estimation of coefficients; statistical significance assessment; statistical evaluation of the coefficient of determination.

2.2. Multiple regression. Classical linear model of multiple regression. Statistical estimates of coefficients. Multicollinearity.

2.3. Nonlinear regression models and linearization.

2.4. Generalized multiple regression models. regression with autocorrelation of residuals.

Topic 3. Basics of discriminant analysis.

3.1. Factor analysis; Formulation of the problem. Criteria for selecting the main components.

3.2. Linear discriminant analysis.

Topic 4. Cluster analysis.

4.1. Formulation of the clustering problem. Types of clustering. Cluster density criteria. the K-means method.

4.2. . Types of intracluster and intercluster distance calculation. Divizyme and agglomerative methods. Methods of cluster analysis in scientific and economic problems.

Topic 5. Concept of time series.

5.1. The genesis of time series data, tasks and goals of time series research.

5.2. Time series smoothing methods

5.3. Analytical methods of exclusion of the deterministic component.

5.4. Trend spline analysis

5.5. Identification of the trend of time series by analytical methods and analysis of a series of residuals

Topic 6. Stationary time series.

6.1. Time series as a discrete random process. Basic characteristics of random processes.

6.2 Stationarity of random processes. Types of stationarity.

6.3. Autocorrelation function and private autocorrelation function.

Topic 7. Models of stationary time series.

7.1. AR(r) autoregression models and their identification.

7.2 Moving average MA(p,q) models and their identification.

7.3. Models of autoregression-moving average ARMA(p, q).

7.4. Estimation of coefficients of ARMA(p, q) processes. Information criteria.

## Topics of the workshops

Topic 1. Multivariate variance analysis.

Topic 2. Construction of a classical linear model of paired regression under conditions of multicollinearity and statistical evaluation of its parameters.

Topic 3. Construction of a classical linear model of multiple regression with autocorrelation of residuals and statistical evaluation of its parameters.

Topic 4. Carrying out factor analysis.

Topic 5. Time series smoothing methods.

Topic 6. Identification of a time series trend by analytical methods and analysis of a series of residuals.

Topic 7. Calculations of the autocorrelation function and the private autocorrelation function.

Topic 8. Study of the stationary series and identification of the AR(r) model.

Topic 9. Investigation of the stationary series and identification of the MA( q) model.

Topic 10. Study of a stationary series and identification of the ARMA(p, q) model.

## Topics of the laboratory classes

Practical classes within the discipline are not provided.

## Self-study

When studying the theoretical material, the student should use the lecture notes and textbooks that are listed in the main bibliography. For more in-depth learning of the material, it is recommended to study individual topics using textbooks from the additional list. Students are also recommended additional materials (videos, articles) for independent study.

After studying the theoretical material, the student should know all the formulations and formulas and know in which situations they should be applied.

The criterion for a student's in-depth assimilation of theoretical material is the ability to solve practical problems. If in the process of working on the study of theoretical material or solving problems, the student has questions that he cannot find out on his own (unclear terms, properties, individual problems), then he or she needs to turn to the teacher for help  
individual task on the topic "Lag models of time series"..

## Non-formal education

Within the framework of non-formal education according to the relevant Regulation (<http://surl.li/pxssv>), the educational component or its separate topics can be taken into account in case of independent completion of professional courses/trainings, obtaining civic education, online education, professional internship, etc.

In particular, individual topics of this component may be taken into account upon successful completion of the following courses:

- Topic 10. "Research and identification of the ARMA(p, q) model"

[https://forms.office.com/Pages/ResponsePage.aspx?id=86sRjMVH00iDWCnUTyDMYCV5ITU\\_WKpIuQYp218a3J1UMzZPRjRUS0N\XQkYwMjIjNDZYUFFQVks0TS4u/](https://forms.office.com/Pages/ResponsePage.aspx?id=86sRjMVH00iDWCnUTyDMYCV5ITU_WKpIuQYp218a3J1UMzZPRjRUS0N\XQkYwMjIjNDZYUFFQVks0TS4u/)

## Course materials and recommended reading

### Basic literature

1. Chuyko S.M., Nesmelova O.V., Chuyko O.S. Mathematical foundations of statistical data processing. – Sloviansk, – 2021. 102 p.
2. Moroz V.S. Econometrics / V.S. Moroz, M.V. Breathe - K.: Center of Educational Literature, 2019. - 206 p. ISBN 978-617-673-486-4
3. Hnedenko B.V. Probability theory course. - K.: Kyiv University, 2010. - 463p. ISBN 978-966-439-206-5  
<https://probability.knu.ua/userfiles/yamnenko/Gnedenko.pdf>
4. Sydorova A. V., Bilenko D. V., Burkina N. V. S 347 Business analytics: educational and methodological manual. Vinnytsia: DonNU named after Vasyl Stus. 2019. 104 p.
5. Hryhorkiv V.S. Modeling of the economy: a textbook / V.S. Hryhorkiv – Chernivtsi: Chernivtsi national. University named after Yu. Fedkovicha, 2019. – 360 p. ISBN 978-966-423-482-2
6. Modeling of the economy: workshop / V.S. Hryhorkiv, M.V. Hryhorkiv Chernivtsi: Chernivtsi. national University, 2023. 208 p. ISBN 978-966-423-788-5  
[https://archer.chnu.edu.ua/bitstream/handle/123456789/8085/ME\\_перши\\_сторинки\\_2023.pdf?sequence=1&isAllowed=y](https://archer.chnu.edu.ua/bitstream/handle/123456789/8085/ME_перши_сторинки_2023.pdf?sequence=1&isAllowed=y)

### Additional literature

7. MATLAB Statistics and Machine Learning Toolbox. User's Guide. - Natick: Mathworks, 2023. - 11098 p.

### Information resources on the Internet

<http://nbuv.gov.ua> – National Library of Ukraine named after V.I. Vernadskyi  
<http://http://www.cgntb.dp.ua> - the Central State Scientific and Technical Library of HMC of Ukraine.  
<http://www.kpi.kharkov.ua> - National Technical University (KPI)  
<http://www-ukr.univer.kharkov.ua> - KHNU named after V.N. Karazin  
<http://korolenko.kharkov.com> – Website of the Kharkiv State Scientific Library named after V.G. Queen  
<https://kpi.ua> – National Technical University of Ukraine "KPI named after Ihor Sikorskyi"  
<https://www.library.kpi.ua> – Scientific and technical library named after G.I. Denisenko KPI named after Igor Sikorsky  
<http://www.library.univ.kiev.ua/ukr/title4.php3> - Scientific Library named after M. Maksymovich Taras Shevchenko KNU  
<https://lpnu.ua/> – Lviv Polytechnic National University;  
<https://library.lpnu.ua> – Scientific and technical library of the Lviv Polytechnic National University  
<https://center.ucu.edu.ua/biblioteka> - Center named after Metropolitan Andrey Sheptytsky of UCU  
<https://www.lnulibrary.lviv.ua> - Ivan Franko LNU Scientific Library.  
<http://www.osvita.org/ua> – Ukrainian Educational Portal  
[https://ukrayinska.libretexts.org/%D0%A1%D1%82%D0%B0%D1%82%D0%B8%D1%81%D1%82%D0%B8%D0%BA%D0%B0/%D0%9A%D0%BD%D0%B8%D0%B3%D0%B0%3A\\_%D0%90%D0%BD%D0%B0%D0%BB%D1%96%D0%B7\\_%D1%87%D0%B0%D1%81%D0%BE%D0%B2%D0%B8%D1%85\\_%D1%80%D1%8F%D0%B4%D1%96%D0%B2\\_\(Aue\)/1%3A\\_%D0%9E%D1%81%D0%BD%D0%BE%D0%B2%D0%BD%D1%96\\_%D0%BF%D0%BE%D0%BD%D1%8F%D1%82%D1%82%D1%8F\\_%D0%B2\\_%D1%87%D0%B0%D1%81%D0%BE%D0%B2%D0%B8%D1%85\\_%D1%B4%D0%B0%D1%85/1.1%3A\\_%D0%92%D1%81%D1%82%D1%83%D0%BF\\_%D1%82%D0%B0\\_%D0%BF%D1%80\\_%D0%B8%D0%BA%D0%BB%D0%B0%D0%B4%D0%B8](https://ukrayinska.libretexts.org/%D0%A1%D1%82%D0%B0%D1%82%D0%B8%D1%81%D1%82%D0%B8%D0%BA%D0%B0/%D0%9A%D0%BD%D0%B8%D0%B3%D0%B0%3A_%D0%90%D0%BD%D0%B0%D0%BB%D1%96%D0%B7_%D1%87%D0%B0%D1%81%D0%BE%D0%B2%D0%B8%D1%85_%D1%80%D1%8F%D0%B4%D1%96%D0%B2_(Aue)/1%3A_%D0%9E%D1%81%D0%BD%D0%BE%D0%B2%D0%BD%D1%96_%D0%BF%D0%BE%D0%BD%D1%8F%D1%82%D1%82%D1%8F_%D0%B2_%D1%87%D0%B0%D1%81%D0%BE%D0%B2%D0%B8%D1%85_%D1%B4%D0%B0%D1%85/1.1%3A_%D0%92%D1%81%D1%82%D1%83%D0%BF_%D1%82%D0%B0_%D0%BF%D1%80_%D0%B8%D0%BA%D0%BB%D0%B0%D0%B4%D0%B8)

## Assessment and grading

### Criteria for assessment of student performance, and the final score structure

Description of the final score structure, course requirements, and necessary steps to earn points, especially paying attention to self-study and individual assignments.

### Grading scale

Total points	National	ECTS
90-100	Excellent	A
82-89	Good	B
75-81	Good	C
64-74	Satisfactory	D
60-63	Satisfactory	E
35-59	Unsatisfactory (requires additional learning)	FX
1-34	Unsatisfactory (requires repetition of the course)	F

## Norms of academic integrity and course policy

The student must adhere to the Code of Ethics of Academic Relations and Integrity of NTU "KhPI": to demonstrate discipline, good manners, kindness, honesty, and responsibility. Conflict situations should be openly discussed in academic groups with a lecturer, and if it is impossible to resolve the conflict, they should be brought to the attention of the Institute's management.

Regulatory and legal documents related to the implementation of the principles of academic integrity at NTU "KhPI" are available on the website: <http://blogs.kpi.kharkov.ua/v2/nv/akademichna-dobrochesnist/>

## Approval

Approved by

Date, signature  
29.08.2024

Head of the department  
Olena AKHIEZER

Date, signature  
29.08.2024

Guarantor of the educational program  
Olena AKHIEZER