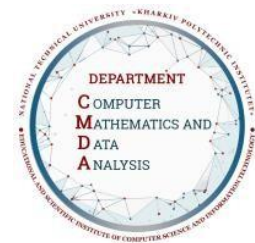




## Syllabus Course Program



# FINANCIAL AND ACTUARIAL MATHEMATICS

### Specialty

113 Applied mathematics

### Institute

Educational and Scientific Institute of Computer Sciences and Information Technologies

### Educational program

Intelligent data analysis

### Department

Computer Mathematics and Data Analysis

### Level of education

Bachelor's level

### Course type

Special (professional), Selective

### Semester

10

### Language of instruction

Ukrainian

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## Lecturers and course developers



### First name and surname

Yevgen.Gomozov@khipi.edu.ua

Academic degree, academic title, position

Associate Professor, Ph.D.-M.Sc., Associate Professor of the Department of KMAD NTU "KhPI". Head of diploma projects and graduate students. Author and co-author of more than 150 scientific and scientific-methodological works. Member of Kharkiv Mathematical Society. Leading lecturer in the disciplines: "Probabilistic and fuzzy models and methods in engineering and economics", "Financial and actuarial mathematics", "Nonlinear processes and models", "Partial differential equations", "Risk analysis", "Financial and actuarial mathematics for Bachelors", "Financial and Actuarial Mathematics for Masters".

[More about the lecturer on the department's website](#)

## General information

### Summary

The course "Financial and Actuarial Mathematics" develops the knowledge and skills necessary for making adequate decisions in the financial and stock markets in order to respond to changes in the situation and analyze data in real time. The course covers the basic concepts of financial and actuarial mathematics, the basic laws of the distribution of random variables, systems of discrete and continuous random variables and their application in problems of financial and actuarial mathematics.

### Course objectives and goals

Provide training of specialists capable of formulating, solving and generalizing practical problems in their professional activities using fundamental and special applied methods of mathematical and computer sciences, developing mathematical models, algorithms, creating and operating appropriate software. Teaching students the basics of financial and actuarial mathematics and their applications, forming in them general functional, subject-specific knowledge on this course.

## Format of classes

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

## Competencies

GC3: Ability for continuous learning, acquiring new knowledge and skills, including in areas other than professional ones.

GC4: Ability to identify, pose, and solve problems in professional activities.

GC5: Ability to generate new ideas (creativity) and unconventional approaches to their implementation, flexible adaptation to real professional situations, displaying a creative approach and initiative.

GC6: Ability to critically evaluate and rethink accumulated experience (own and others'), analyze one's professional and social activities.

GC7: Ability to work with information, find and use information from various sources necessary for solving professional tasks.

GC8: Effective communication skills, taking into account the goals and situation of communication.

SC1: Ability to formulate a mathematical problem, relying on the language of the subject area, verifying the correctness of the formulation, including under conditions of uncertainty.

SC2: Ability to choose, develop, and investigate mathematical, analytical, or numerical methods for solving practical problems that ensure the required accuracy and reliability of the result.

SC3: Ability to choose, develop, investigate, and apply mathematical methods for solving practical problems of modeling, design, management, forecasting, decision-making.

SC10: Ability to choose, develop, investigate, and apply mathematical models and methods for intelligent data analysis under conditions of uncertainty.

## Learning outcomes

LO2: Ability to formalize problems formulated in the language of a specific subject area, choose a rational method for solving them, solve problems using analytical or numerical methods, assess the accuracy and reliability of the results, and interpret them.

LO4: Ability to combine methods of mathematical and computer modeling with informal expert analysis procedures to search for optimal solutions.

LO7: Apply modern programming technologies and software development, implement numerical and symbolic algorithms.

## Student workload

The total volume of the course is 150 hours (5 ECTS credits): lectures - 20 hours, laboratory classes - 30 hours, self-study - 100 hours.

## Course prerequisites

To successfully complete the course, you must first complete the following courses: "Theory of Probability", "Mathematical Statistics", "Mathematical Analysis".

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

Lectures are conducted interactively. Project approach when performing laboratory work, attention is focused on the application of information technologies in mathematical modeling of applied problems; independent study of software products related to working with numerical methods of solving problems from nonlinear processes and models, use of electronic resources. Study materials are available to students through Office 365.

## Program of the course

### Topics of the lectures

Topic 1. Basic concepts of financial mathematics

The first subtopic: Financial transaction, financial markets.

The second subtopic: The main indicators of the efficiency of a financial transaction, the specifics of terminology.

The third subtopic: Financial interest rate, its form and types, accounting rate.

The fourth sub-topic: Simple, compound and continuous interest rates.

The fifth subtopic: operations of accretion and discounting, accounting for inflation according to the Fisher formula

Topic 2. Peculiarities of financial calculations.

The first subtopic: cash flows, nominal, real, effective interest and discount rate.

The second subtopic: equivalence of cash flows.

The third subtopic: Annuities, their types and value, the use of annuities in various financial models.

Topic 3. Spot and futures markets

The first subtopic: exchange and over-the-counter financial assets.

The second subtopic: Risk analysis of financial transactions.

The third subtopic: Risky and risk-free financial assets.

Topic 4. Financial investments.

The first subtopic: Performance indicators of financial investments.

The second subtopic: Models of securities markets.

The third subtopic: Elements of the portfolio theory.

Topic 5. Actuarial calculations.

The first subtopic: Tariff rate.

The second subtopic: The essence and types of insurance premiums.

The third subtopic: Property insurance, its structure and types.

The fourth subtopic: Life insurance (probabilistic characteristics of life expectancy).

The fifth subtopic: Determination of the insurance tariff in life insurance.

The sixth subtopic: Tariff rates, rates of return, analytical laws of mortality.

Topic 6. Basics of risk modeling in insurance.

The first subtopic: Analysis and risk management in insurance.

The second subtopic: Estimation of the current value of the firm.

Topic 7. Static models of insurance company bankruptcy.

The first subtopic: bankruptcy forecasting models.

The second subtopic: criteria for the probability of a financial crisis.

Topic 8. Dynamic models of insurance company bankruptcy.

First subtopic: Bayesian approach.

The second sub-theme: ensuring solvency..

### **Topics of the workshops**

Practical classes within the discipline are not provided.

### **Topics of the laboratory classes**

Topic 1. Financial calculations using simple and compound interest.

Topic 2. Derivative interest calculations. Calculation of equivalent parameters of financial transactions.

Topic 3. Conversion of financial rents. Variable annuities.

Topic 4. Calculation and analysis of performance indicators of financial operations and investments.

Topic 5. Analysis of personal insurance conditions in Ukraine.

Topic 6. Analysis of property and liability insurance conditions in Ukraine.

Topic 7. Actuarial calculations for life insurance.

Topic 8. Actuarial calculations for insurance other than life insurance.

### **Self-study**

The course involves the implementation of an individual calculation task for modeling and calculating the design parameters of specific examples. The result of calculations and modeling is drawn up in a written report. Students are also recommended additional materials for independent study and analysis.

## **Course materials and recommended reading**

- Roberts, A. J. Elementary calculus of financial mathematics / A. J. Roberts. p. cm. -- (Mathematical modeling and computation; 15) Includes bibliographical references and index. ISBN 978-0-898716-67-2.
- Baxer M., Rennie A. Financial calculus: An introduction to derivative pricing/ – Cambridge: Cambridge University Press, 1996. – 233 p.
- Capinski M., Zastawniak T. Mathematics for Finance: An introduction to financial engineering. – London: Springer Verlag, 2011. – 322 p.
- Etheridge A. Financial Calculus – Cambridge: Cambridge University Press, 2006.

## 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