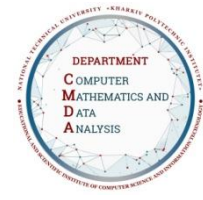




Syllabus Course Program



Decision Making Theory

Specialty

113 Applied mathematics

Institute

Educational and Scientific Institute of Computer Science and Information Technology

Educational program

Intelligent Data Analysis

Department

Computer Mathematics and Data Analysis

Level of education

Bachelor's level

Course type

Special (professional), Mandatory

Semester

7

Language of instruction

Ukrainian

Lecturers and course developers

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Author of scientific and educational and methodical works. Leading lecturer in the disciplines: "Fuzzy models and methods", "Big data infrastructure and management", "Introduction to the specialty and engineering activity"

General information

Summary

The discipline is aimed at mastering the basics of decision-making theory. Methods and models of decision-making as a choice of options from a given set of alternatives under various types of uncertainties, based on modern optimization technologies and aimed at obtaining a specific final result, are considered.

Course objectives and goals

Acquisition of the necessary competencies for the use of mathematical methods of optimization and decision-making, in particular: the ability to develop and implement new information technologies and software for management, design, decision-making, search, analysis and data processing, the ability to master modern technologies and decision-making systems based on constructive – geometric interpretation of problems and models of engineering, mathematical and information technology sciences.

Format of classes

Lectures, workshops, calculations, consultations. The final control is 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 8. Knowledge and understanding of the subject area and understanding of professional activities.

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

SC 14. Ability to understand the task statement formulated in the language of a particular subject area, to search and collect the necessary initial data.

SC 18. Ability to select and apply mathematical models and methods for statistical and intellectual analysis of data under conditions of uncertainty.

SC 19. Ability to apply mathematical methods and algorithms of machine learning, soft computing and computational intelligence to analyze uncertain data, forecasting and decision-making.

SC 22. Ability to use information technologies for statistical and intellectual data analysis, forecasting, decision-making, information retrieval and knowledge extraction.

Learning outcomes

LO 1. Demonstrate knowledge and understanding of basic concepts, principles, theories of applied mathematics and use them in 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 field; formulate their mathematical formulation and choose a rational method of solution; solve the resulting problems with analytical and numerical methods; evaluate the accuracy and reliability of the results obtained.

LO 8. Combine methods of mathematical and computer modeling with informal peer review procedures for search for optimal solutions.

LO 10. To have methods for choosing rational methods and algorithms for solving mathematical optimization problems, research operations, optimal management and decision-making, and data analysis.

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

Student workload

The total volume of the course is 90 hours (3 ECTS credits): lectures – 28 hours, practical classes – 16 hours, self-study – 46 hours.

Course prerequisites

"Computer discrete mathematics", "Probability theory", "Mathematical statistics", "Theory and design of algorithms", "Optimization methods".

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

A feature of teaching is the use of elements of project work.

Program of the course

Topics of the lectures

Topic 1. Formulation of the decision-making problem

- Examples of decision-making problems.
- Formulation of the decision-making problem.

Topic 2. Analysis of the decision-making problem

- Criterion language of the selection task.
- Choice task in the language of binary relations.

Decision Theory



- Properties of binary relations.
- Formal models of the decision-making problem.
- Principles of construction of membership functions of fuzzy sets.
- Stochastic and linguistic uncertainty.

Topic 3. Connection of different means of setting a choice

- Single-criteria and multi-criteria selection.
- Pareto set.
- Slater's set.

Topic 4. Selection functions

- Better options.
- Imitation property.
- The condition of independence from rejected alternatives.
- The property of agreement.

Topic 5. Multi-criteria decision-making models under conditions of certainty. Methods of multicriteria optimization

- The main criterion method.
- The method of linear convolution.
- Maximin convolution method.
- Maximum strategies.

Topic 6. Problems with a small number of criteria and alternatives. AHM

- The problem of ranking objects by "importance".
- Matrix of pairwise comparisons.
- Saaty method.
- The method of Kogger and Yu.

Topic 7. Discussion of the methods of Saati, Cogger and Yu

- Disadvantages of the considered methods and ways to eliminate them.
- A simple selection algorithm.
- The method of constraints.

Topic 8. Models and methods of decision-making under conditions of certainty

- Results by section.
- Control work #1.

Topic 9. Decision-making under conditions of risk

- Formalization of the decision-making process.
- Decision matrix.
- Evaluation function.
- Decision-making under conditions of risk.

Topic 10. Classical decision-making criteria. Decision-making criteria under conditions of complete uncertainty. Derived decision-making criteria

- Bayes-Laplace criterion.
- Criterion of mathematical expectation-dispersion.
- Bernoulli's criterion of insufficient justification.
- Wald criterion.
- Minimax criterion.
- Savage criterion.
- Hurwitz criterion.
- Decision-making under conditions of risk.
- Calculation task.

Topic 11. Decision-making under conflict conditions

- Elements of game theory.
- A decision-making problem with an active adversary.
- Endless antagonistic games.
- The principle of a guaranteed result.

Topic 12. Peculiarities of decision-making under conflict conditions

- Nash's principle of stability.
- Cooperative games.
- Neumann-Morgenstern solution.
- Shapley's axioms.
- Communication of the principles of decision selection.

Topic 13. Multi-criteria selection under conditions of uncertainty

- Multidimensional decision matrix.
- Utility functions.
- Analysis of conditions of independence of partial criteria.

Topic 14. Models and methods of decision-making under conditions of uncertainty

- Results by section.
- Control work #2.
- Conclusions on the subjects of the discipline.

Topics of the workshops

Topic 1. Selection of the optimal alternative using unconditional optimization methods

Topic 2. Search for a set of Pareto-optimal solutions of a multi-criteria problem

Topic 3. Choice functions in multi-criteria decision-making problems. The use of multi-criteria optimization methods in decision-making problems

Topic 4. Decision-making using MAI (Saati method; Cogger and Yu method; simple selection algorithm)

Topic 5. Decision-making under conditions of uncertainty (according to classic decision-making criteria under conditions of risk)

Topic 6. Decision-making under conditions of uncertainty (based on derived decision-making criteria under conditions of complete uncertainty)

Topic 7. Decision-making under conditions of risk

Topic 8. Protection of calculation tasks

Topics of the laboratory classes

Laboratory classes are not provided for in the curriculum.

Self-study

During self-study, students study the lecture material, perform calculation tasks (C), prepare for tests and exams. Correctly performed calculation tasks are credited, incorrectly performed - returned for revision. Calculation tasks are evaluated as completed after correcting errors.

Non-formal education

Within the framework of non-formal education according to the relevant Regulation ([z0328-22](#)), the educational component or its separate topics can be taken into account in case of independent completion of professional courses/training, 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 2. Analysis of the decision-making problem

<https://www.coursera.org/specializations/decisionmakingforeveryone#outcomes>

- Topic 11. Decision-making under conflict conditions

<https://www.coursera.org/learn/game-theory-1>

- Topic 12. Peculiarities of decision-making under conflict conditions

<https://www.coursera.org/learn/game-theory-1>

Course materials and recommended reading

Basic literature

1. Негрей М.В., Тужик К.Л. Теорія прийняття рішень. – К. Центр учбової літератури, 2022. – 272с.

2. А. В. Катренко, В. В. Пасічник. Прийняття рішень: теорія та практика : підручник [Електронний ресурс] / А. В. Катренко, В. В. Пасічник. – Львів : «Новий Світ – 2000», 2020. – 447 [1] с.

https://ns2000.com.ua/wp-content/uploads/2019/07/Pryyniattia_rishen.pdf

3. Теорія прийняття рішень [Електронний ресурс] : навчальний посібник для студентів спеціальності 126 «Інформаційні системи та технології» та спеціальності 121 «Інженерія програмного забезпечення» / КПІ ім. Ігоря Сікорського ; уклад. О. С. Жураковська. – Електронні текстові дані (1 файл: 4,09 Мбайт). – Київ : КПІ ім. Ігоря Сікорського, 2020. – 99с.

https://ela.kpi.ua/bitstream/123456789/38902/1/TPR_Posibnyk.pdf

Additional literature

4. Прийняття рішень: теорія та практика : підручник / А. В. Катренко, В. В. Пасічник. – Львів : «Новий Світ – 2000», 2020. – 447 [1] с.
5. М.П.Горський, Д.В. Бординюк, С.В. Голуб. Теорія прийняття рішень: Навч. посібник [Електронний ресурс] / Горський М.П., Бординюк Д.В., Голуб С.В. – Чернівці: Чернівецький нац. ун-т, 2022. – 84 с.
https://archer.chnu.edu.ua/bitstream/handle/123456789/6424/%D0%A2%D0%9F%D0%A0_%D1%82%D0%B8%D1%82%D1%83%D0%BB2.pdf?sequence=1&isAllowed=y
6. Теорія прийняття рішень [текст] підручник [Електронний ресурс]. / За заг. ред. Бутка М. П. [М. П. Бутко, І. М. Бутко, В. П. Мащенко та ін.] – К. : «Центр учбової літератури», 2018. – 360 с.
<https://files.znu.edu.ua/files/Bibliobooks/Inshi56/0041360.pdf>

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