Syllabus
Course Program

Decision-making tools and algorithms

Code and name of specialty
123 – Computer engineering

Institute
National Institute of Computer Sciences and Information Technologies

Educational program
Modern programming, mobile devices and computer games

Chair
Computer engineering and programming (326)

Educational level
Master's degree

Type of discipline
Special (professional), mandatory

Semester
9

Language of teaching
Ukrainian, English

Lecturers and course developers

Leonov Serhii
Serhii.Leonov@khpi.edu.ua
Doctor of technical sciences, professor, professor of the department of computer engineering and programming of NTU "KhPI".
Work experience - 40 years. Author of more than 230 scientific and educational and methodological works. Leading lecturer in the disciplines: «Computer systems», «Automated design of computer systems», «VHDL the language of designing high-level computing equipment» «Basics of artificial intelligence».
Learn more about the teacher on the department's website
https://web.kpi.kharkov.ua/cep/2022/05/15/leonov-serhii-yuriyovich/

Zakovorotnii Oleksandr
Oleksandr.Zakovorotnii@khpi.edu.ua
Doctor of technical sciences, professor, head of the department of computer engineering and programming of NTU "KhPI".
Досвід роботи – 20 років. Автор понад 200 наукових та навчально-методичних праць. Провідний лектор з дисциплін: «Основи обчислювального інтелекту», «Основи нейрокомп'ютингу»
Learn more about the teacher on the department's website
https://web.kpi.kharkov.ua/cep/2021/09/03/zakovorotnyj-oleksandr-yurijovych/

Filatova Hanna
Hanna.Filatova@khpi.edu.ua
Doctor of technical sciences, professor, professor of the department of computer engineering and programming of NTU "KhPI"
Work experience - 25 years. Author of more than 180 scientific and educational and methodological works. Leading lecturer in the disciplines: «Development and design of databases», «Signal and Image Processing», «Design of computer diagnostic systems».
Learn more about the teacher on the department's website
https://web.kpi.kharkov.ua/cep/2022/05/14/filatova-ganna-yevgenivna/

General information

Abstract

The discipline "Decision-making tools and algorithms" is one of the profiling disciplines. It provides theoretical, practical and engineering training for the implementation of decision-making methods and algorithms in the development of problem-oriented software and hardware, necessary for the study of related disciplines, as well as for course and diploma design

Course objectives and goals

The subject of the discipline "Decision-making tools and algorithms" is the study of methods of finding solutions in non-conflict and conflict situations, as well as the assessment of possible solutions in conditions of certainty, uncertainty and risk.
The goal of the discipline is: students to acquire theoretical knowledge in the field of formalized search and decision-making processes; acquiring skills in formalizing conflict situations; acquiring knowledge in the field of quantitative justification of decisions in engineering, organizational, research and commercial activities.

Format of classes

Lectures, practical classes, workshops, independent work, consultations. The final control is an exam.

Competencies

ZK 2. Ability to abstract thinking, analysis and synthesis.
ZK 7. Ability to make informed decisions.
CK11. The ability to choose effective methods of solving complex computer engineering problems, critically evaluate the obtained results and argue the decisions made

Learning outcomes

RN 10. Search for information in various sources to solve computer engineering problems, analyze and evaluate this information.
PH11. Make effective decisions regarding the development, implementation and operation of computer systems and networks, analyze alternatives, assess risks and likely consequences of decisions.

Scope of the discipline

The total volume of the discipline is 150 hours. (5 credits ECTS): lectures – 32 hours., practical classes – 32 hours., independent work – 86 hours.

Prerequisites for studying the discipline (prerequisites)

The discipline is based on the study of the disciplines "Theory of probability", "Discrete mathematics", mathematical packages Excel, MATLAB, etc.

Features of the course, teaching and learning methods and technologies

Lectures are conducted interactively using multimedia technologies. Lectures use: narration, explanation, demonstration, discussion.
In practical classes, students perform individual tasks for calculating model parameters and statistical characteristics of research objects. For this, they use personal computers and mathematical packages: Excel, Matlab, etc.
According to the sources of knowledge, the following teaching methods are used: verbal - narration, explanation, instruction; visual - demonstration, illustration; laboratory work, exercises, tests. According to the nature of the logic of knowledge, the following methods are used: analytical, synthetic, analytical-synthetic, inductive, deductive.
According to the level of independent mental activity, methods are used: problem-based, partially research-based, research.
Educational materials are available to students in the Google Disk cloud environment.

Program of the course

Topics of the lectures

Topic 1. *Formal structure of decision-making problems*
The structure of the decision-making task and the classification of decision-making tasks according to the connection between the means and the result.
Ways of formalizing the goal in decision-making tasks.
Decision-making in the optimization of the objective function under conditions of certainty, uncertainty and risk
Topic 2. *Classical decision-making criteria.*
Classical decision-making criteria under conditions of uncertainty.
Decision-making criteria in conditions of risk.
Derived decision-making criteria.
Topic 3. Decision-making criteria for the creation of technical systems.
Classical decision-making criteria in technical systems. Their shortcomings when evaluating real algorithms, software and hardware.
Main characteristics of the software. International standards for software development.
Multipurpose solutions.
Synthesis of multicomponent criteria by the method of group consideration of arguments.
Topic 4. Solving problems with vector criteria.
Absolute preference rule and majority rule preference.
Reduction of the vector criterion to the scalar one.
Reduction of a multi-criteria problem to the search for the extremum of a single goal under the conditions of restrictions.
Lexicographic method of solving multi-criteria problems.
Topic 5. *Matrix games.*
Basic provisions and definitions of game theory.
Two-player matrix games.
Methods of solving two-player matrix games.
Topic 6. *Multi-step and continuous games.*
Multi-step games and methods of their solution.
Continuous games. Games on a single square.
Topic 7. *Mathematical apparatus of the theory of relations.*
Ordered sets and binary relations. Basic concepts of the theory of relations.
Special properties of relations.
Description of benefits in the language of relationships.
Topic 8. *Decision-making when assigning benefits in the form of relationships.*

Formalization of choice problems based on the apparatus of binary relations and the theory of ordered sets.
Diagrams of order relations.
Algorithms for choosing solutions when assigning preferences in the form of binary relations.
Topic 9. *Computer decision support systems.*
General characteristics CDSS.
Architecture CDSS.
Examples CDSS.

Topics of the workshops

Topic 1. Study of criteria for decision-making in conditions of uncertainty.
Obtaining and consolidating knowledge, forming practical skills for working with criteria for decision-making in conditions of uncertainty.
Topic 2. A study of criteria with regrets.
Obtaining and consolidating knowledge, forming practical skills for working with criteria with regrets for decision-making in conditions of uncertainty.
Topic 3. Study of criteria for decision-making in conditions of risk.
Obtaining and consolidating knowledge, forming practical skills for working with criteria for decision-making in conditions of risk.
Topic 4. Synthesis of multicomponent criteria by an algorithm with linear partial descriptions of the method of group consideration of arguments.
Obtaining and consolidating knowledge, forming practical skills of working with an algorithm with linear partial descriptions of the method of group consideration of arguments in the synthesis of multi-component decision-making criteria under conditions of uncertainty.
Topic 5. Synthesis of multicomponent criteria by an algorithm with nonlinear partial descriptions of the method of group consideration of arguments.
Obtaining and consolidating knowledge, forming practical skills for working with an algorithm with nonlinear partial descriptions of the method of group consideration of arguments in the synthesis of multicomponent decision-making criteria under conditions of uncertainty.
Topic 6. Formalization of conflict situations using game theory.
Obtaining and consolidating knowledge, forming practical work skills when formalizing conflict situations using game theory.
Topic 7. Solving matrix games by the method of successive approximation of the price of the game.
Obtaining and consolidating knowledge, forming practical work skills for numerically solving matrix games.
Topic 8. Solving decision-making problems using vector criteria.
Obtaining and consolidating knowledge, forming practical skills for solving decision-making problems using vector criteria

Topics of laboratory work

Laboratory work within the discipline is not provided.

Self-study

The student's independent work is reduced to studying the lecture material, preparing for laboratory classes, performing an individual version of the calculation task using methodical recommendations. The topics of the tasks for performing the computational and graphic task correspond to the topics of the master's thesis (the abstract of the master's thesis is being performed). This encourages students to correctly allocate time for the completion of the master's work, more in-depth study of the theoretical part of the master's work and, as a result, better performance of the master's work.
Students are also recommended additional materials (videos, articles, textbooks) for independent study and analysis, preparation for lectures, practical and laboratory classes.

Course materials and recommended reading

Primary literature

1. Dmytrienko V.D., Kravets V.O., Leonov S.Yu. Introduction to the theory and methods of decision-making: Study guide. – Kharkiv: NTU "KhPI",2010. – 139 p.
2. Dmytrienko V.D., Zakovorotny O.Yu. Decision-making tools and algorithms: Laboratory workshop. – Kharkiv: NTMT, 2012. – 76 p.
3. Dmytrienko V.D., Zakovorotny O.Yu., Noskov V.I. Decision-making tools and algorithms: educational and methodological guide to practical classes. – Kharkiv: NTMT, 2013. – 76 c.
4. Decision support systems: Training manual / O.I. Pushkar, V.M. Hikovaty, O.S. Yevseev, A.V. Potrashkova. Under the editorship Dr. Econ. Sciences, Prof. Pushkarya O.I. – Kharkiv: VD "INZHEK",2006. – 304 p.
5. Protasov I.D. Game Theory and Operations Research: A Study Guide. – M.: Helios ARV, 2006. – 368 p.
6. Shikin E.V. From games to games: A mathematical introduction. Kind. 3rd, add. – M.: KomKnika,2006. – 112 p.

Additional literature

7. Eddows M., Stansfield R. Decision-making tools. – M.: "Audit", UNITI, 1997.
8. Knyazevska N.V., Knyazevsky V.S. Making decisions in economics and business. – M.: “Kontur”, 1998.
9. Larichev O.I. The theory and methods of making decisions – M.: “Logos”,2000.
10. Kuznetsov A.V., Sakovich V.A., Kholod N.I. Vishcha mathematics. Mathematical programming. – Minsk: “Visheyshaya school”,1994.
11. Mushik E., Muller P. Methods for praising technical solutions.– M.: "Science",1990.
12. Trakhtengerts E.A. Computer support will make a decision. – M.: SINTEG,1998.
13. Verlan A.F. Dmitrienko V.D., Korsunov M.I., Shorokh V.A. Evolutionary methods of computer modeling – K.: “Naukova Dumka”,1992.
14. Ivakhnenko O.G. Continuity and discreteness. – K.: “Naukova Duma”,1990.
15. Berezovsky B.A., Borzenko V.I., Kempner L.M. Binary data for rich criteria optimization – M.: “Nauka”,1981.
16. Rosen V.V. The goal is optimality – solutions (mathematical models for arriving at optimal solutions). – M.: “Radio and connection”,1982.
17. Lipaev V.V. Standardization of characteristics and evaluation of the quality of software features // Supplement to the journal "Information Technologies", № 4, 2001.

Assessment and grading

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

The final grade consists of the assessment results in the form of an exam (40%) and ongoing assessment (60%). Exam: written assignment (2 theory questions + problem-solving) and an oral presentation. Ongoing assessment: 2 online tests (15%), laboratory works (35%), and a computational assignment (10%).

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	Head of the department Oleksandr ZAKOVOROTNYI
	Date, signature	Guarantor of the educational program Svitlana GAVRYLENKO