Syllabus
Course Program

Methods and algorithms of decision making

Specialty
122 – Computer sciences

Institute
Institute of Computer Modeling, Applied Physics and Mathematics

Educational program
Computer science. Modeling, design, and computer graphics

Department
Mathematical modeling and intelligent computing in engineering (161)

Level of education
Bachelor's level

Course type
Special (professional), Mandatory

Semester
6

Language of instruction
English, Ukrainian

Lecturers and course developers

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Field of scientific interests: navigation, navigation systems, traffic control, decision-making problems. Author and co-author of more than 30 scientific and methodological publications. Courses: probability theory, mathematical statistics, random processes, decision theory, system analysis, information theory and coding.
http://web.kpi.kharkov.ua/cmps/uk/nekrasova-mariya-volodimirivna/

General information

Summary

The course examines methodological issues of system analysis and decision-making theory, used principles and ideas, specific tasks that are solved for systems of different levels, functioning in different conditions. The scheme of system analysis, which is used in finding solutions to problems related to systems, is considered. The main aspects of systems theory are discussed: analysis, synthesis, creation of the environment, the main tasks of operations research, decision-making methods are considered

Course objectives and goals

Master the methodology of a systematic approach to formulation, formalization and problem solving in any professional field. Familiarize yourself with the methods of system analysis and decision-making methods in different conditions.

Format of classes

Lectures, laboratory classes, consultations, self-study. Final control in the form of a tests.

Competencies

GC1 Ability to think abstractly, analyze and synthesize.
GC2 Ability to apply knowledge in practical situations
GC4 Ability to communicate in a foreign language
GC5 Ability to learn and master modern knowledge
GC6 Ability to be critical and self-critical.
GC7 Ability to generate new ideas (creativity)

Learning outcomes

PC1 Understanding of the theoretical foundations of computer science
PC7 Ability to develop software in accordance with the formulated requirements, taking into account available resources and constraints
PC9 Ability to develop and administer databases and knowledge
LO1Have specialized conceptual knowledge, including modern
scientific achievements in the field of computer science and is the basis for original thinking and research, critical thinking of problems in the field of computer science and on the border of knowledge fields
LO2 Have specialized skills/abilities to solve computer science problems necessary for research and/or innovation activities to develop new knowledge and procedures
LO3 Clearly and unambiguously communicate own knowledge, conclusions and arguments in the field of computer science to specialists and non-specialists, including students.
LO11 Create new algorithms for solving problems in the field of computer science, evaluate their effectiveness and limitations on their application
LO12 Design and maintain databases and knowledge
LO17 Identify and eliminate problem situations during software operation, formulate tasks for its modification or reengineering
LO18 Collect, formalize, systematize and analyze the needs and requirements for the information or computer system being developed, operated or maintained

Student workload

The total volume of the course is 120 hours (4 ECTS credits): lectures - 32 hours, laboratory classes - 16 hours, self-study - 72 hours.

Course prerequisites

Knowledge of the main sections of the linear algebra course, probability theory, optimization methods

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

Teaching methods consist in combining understanding of lecture material with the ability to think logically and abstractly. Peculiarities of training consist in a large number of tasks performed within laboratory classes and independent work. Most problems are solved independently analytically.

Program of the course

Topics of the lectures

Topic 1. Basics of analysis of complex systems
Lecture 1: Course structure, purpose and tasks. System methodology: an overview of the development of system analysis, the reasons for the spread of the methodology. System paradigm, definition of system, classification of systems, concepts characterizing systems, properties of systems, complexity of systems.
Lecture 2: System modeling: basic problems of systems theory, problems of resource distribution in systems, modeling of system behavior. Models of system dynamics. Modeling methods.
Lecture 3: Design of systems: decomposition of systems, design of systems, moral problems of design, informational aspect of studying systems
Lecture 4: Mathematical methods of system analysis: mathematical description of systems and their properties, methods of studying the structure of systems. Determination of reliability and quality of systems.

Topic 2. Decision-making models and methods

Lecture 5: Problems and methods of decision-making in systems: classification of decision-making problems, decision-making models.
Lecture 6: Methods of solving multi-criteria selection problems.
Lecture 7: Making decisions in conditions of complete certainty. Hierarchy analysis method.
Lecture 8: Hierarchy analysis method. Examples of problems.
Lecture 9: Decision-making in conditions of risk. The expected value method is simple and complicated by additional information.
Lecture 10: The Expected Value Method – Simple and Complicated by Additional Information. Examples of problems.
Lecture 11: Utility functions
Lecture 12: Decision-making methods under conditions of uncertainty. Selection criteria.
Lecture 13: Decision-making methods under conditions of uncertainty. Selection criteria. Examples of problems.
Lecture 14-16: Using the theory of fuzzy sets to solve optimal choice problems

Topics of the workshops

absent

Topics of the laboratory classes

Laboratory 1-2: System-mathematical modeling of socio-economic systems. Determination of the optimal plan for the task of using raw materials.
Laboratory 3-4: The task of drawing up a work plan according to the list. Control work.
Laboratory 5-6: Decision-making tasks under conditions of complete certainty. Hierarchy analysis method. Control work.
Laboratory 7: Decision-making tasks under conditions of risk. Criterion of expected value. Control work
Laboratory 8: Problems of decision-making under conditions of uncertainty. Criteria minimax, Laplace, Hurwitz, Savage, products. Control work..

Self-study

The topics for independent work are: Formulation of problems of system analysis from one's own professional, educational or everyday activities and application of methods of system analysis to them. In-depth study of decision-making methods for non-formalized and weakly formalized problems. Familiarity with the basics of fuzzy logic and the method of fuzzy inference for management tasks and forecasting the behavior of systems under conditions of uncertainty

Course materials and recommended reading

1. Annany M.; Towards an ethics of algorithms: convening, observation, probability, and timeliness; Science, Technology, and Human Values (41); 2015.
2. Bostrom N.; Superintelligence: Paths, dangers, strategies; Oxford University Press; 2014.
3. Desai D. and Kroll J.; Trust But Verify: A Guide to Algorithms and the Law; Harvard Journal of Law and Technology (31); 2018.
4. Goodman B., Flaxman S.; European Union regulations on algorithmic decision-making and a 'right to explanation'; AI Magazine; 2017.
5. Kleinberg J., Lakkaraju H., Leskovec J., Ludwig J., Mullainathan S.; Human decisions and machine predictions; National Bureau of Economic Research, NBEC Working Paper 23180; 2017
6. Lou Y., Caruana R., Gehrke J.; Intelligible models for classification and regression; Proceedings of the ACM Knowledge Discovery and Data Mining Conference (KDD); 2012.
7. Wachter S., Mittelstadt B., Russel C.; Counterfactual explanations without opening the black box, automated decisions and the GDPR; Harvard Journal of Law & Technology; 2018.

Assessment and grading

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

Laboratory works - a maximum of 30 points. Passing oral colloquiums on theory - a maximum of 40 points. Performance of control works - a maximum of 30 points.

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 Dmytro BRESLAVSKY
	Date, signature	Guarantor of the educational program Oleksii VODKA