Syllabus
Course Program

Decision Making Theory

Specialty
121 – Software Engineering

Institute
Institute of Computer Science and Information Technology

Educational program
Software Engineering

Department
Software Engineering and Management Intelligent Technologies (321)

Level of education
Bachelor's level

Course type
Special (professional), Mandatory

Semester
7

Language of instruction
English, Ukrainian

Lecturers and course developers

Mykhailo Godlevskyi

mykhailo.hodlevskyi@khpi.edu.ua
Doctor of Technical Sciences, Professor, Head of the Institute of Computer Science and Information Technology, NTU "KhPI".

Work experience since 1977. Number of scientific and educational publications - 171, including 4 collective monographs, 4 textbooks (Google Scholar https://scholar.google.com.ua/citations?user=_tDsBHEAAAAJ&hl=ru; ORCID-ID https://orcid.org/0000-0003-2872-0598; Scopus ID https://www.scopus.com/authid/detail.uri?authorId=57202891828)
Leading lecturer in disciplines: «Decision making theory», «Models and methods of decision making support».
Member of the SMC of Ukraine in Computer Science, executive editor of the collection of scientific papers «Bulletin of NTU «KhPI», member of the special council on Information Technology.
Scientific directions: support of decision-making in management tasks of distributed systems development; system optimization; quality of the software development process.
More about the lecturer on the department's website

General information

Summary

Decision making theory is considered as a component of systems analysis and systems theory. The main stages of solving the decision-making problem, which is based on vector optimization, are given. The main methods of solving multicriteria optimization problems are presented. Expert methods of decision evaluation and information technologies of decision support systems are considered.

Course objectives and goals

Mastering the general concepts, methods, models and information technologies of decision support in the implementation of the bachelor's thesis in order to obtain competencies sufficient for practical use in the professional activities of specialists in the specialty "information systems and technologies".

Format of classes

Lectures, laboratory classes, consultations. Final control - exam.

Competencies

К01. Ability to think abstractly, analyze and synthesize.
К02. Ability to apply knowledge in practical situations.
К05. Ability to learn and master modern knowledge.
К06. Ability to search, process and analyze information from various sources.
К20. Ability to apply fundamental and interdisciplinary knowledge to successfully solve software engineering problems.
К21. Ability to evaluate and take into account economic, social, technological and environmental factors that affect the field of professional activity.
К26. Ability to think algorithmically and logically.

Learning outcomes

PLO01. Analyze, purposefully search and select information and reference resources and knowledge necessary for solving professional problems, taking into account modern achievements of science and technology.
PLO05. To know and apply relevant mathematical concepts, methods of domain, system and object-oriented analysis and mathematical modeling for software development.
PLO11. Select input data for design, guided by formal methods of requirements description and modeling.
PLO12. Apply effective approaches to software design in practice.
PLO24. Be able to calculate the economic efficiency of software systems.

Student workload

The total volume of the course is 120 hours (4 ECTS credits): lectures - 48 hours, laboratory classes - 16 hours, self-study - 56 hours.

Course prerequisites

The basis for studying the discipline is the general mathematical training of students and the content of the discipline "Operations Research".

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

Teaching and learning methods:
interactive lectures with presentations, discussions, laboratory classes, teamwork, case method, student feedback, problem-based learning.
Forms of assessment:
written individual assignments for laboratory work (CAS), assessment of knowledge in laboratory classes (CAS), express surveys (CAS), online tests (CAS), final/semester control in the form of a semester exam, according to the schedule of the educational process (FAS).

Program of the course

Topics of the lectures

Theme 1. Course subject and objectives, object of study, course structure. Examples of the use of decision theory in various spheres of human life. Systemological analysis of decision-making problems
Theme 2. The problem of decision making as a component of systems analysis and systems theory. Setting and stages of solving decision-making tasks. Difficulties the problem of a unique choice. The problem of evaluation.
Theme 3. Classification of methods for evaluation and comparison of multicriteria alternatives. Axiomatic methods. Direct methods. Methods of compensation. Methods of incomparability thresholds. Human-machine decision-making procedures.

Theme 4. Measurement and scaling of partial criteria. Scales: names, order, intervals, relations. Absolute scales.
Theme 5. Vector optimization based on a radical approach. Pareto and Slater sets. Theoretical and practical meaning of effective solutions.
Theme 6. Properties of effective alternatives and ways to find them. Basic theorems of vector optimization. The concept of an effective generalized criterion and solution in the problem of multicriteria optimization. The method of constraints in finding compromise solutions in vector optimization problems.
Theme 7. Binary relations in decision theory. Operations on binary relations. The concept of the selection function. Functions and mechanisms of choice. Properties of selection mechanisms.
Theme 8. Utility theory. Utility types. Rational choice based on the utility function. Conditions for the existence of the utility function. Values identification of utility functions parameters. Conditions of criteria independence. Multicriteria utility theory.
Theme 9. Lexicographic optimization problems. Examples of lexicographic problems. Research of lexicographic problem. Representation of a lexicographical relation by one functional. The method of action.
Theme 10. Decision support based on system optimization. The method of forming effective solutions. Classification of system optimization problems. System optimization algorithms.
Theme 11. Saati pairwise comparison method. Examples of use.
Theme 12. Solve poorly structured problems by analytical hierarchy. Hierarchies of priorities and justification of the method. Algorithm and practical implementations of the method.
Theme 13. Methodology of collective expert evaluation. Formation of an expert group. Generation of expert information Examination. Aggregation of expert judgments.
Theme 14. Information technologies of decision support systems (DSS). DSS structure. DSS actors. Examples of DSS.

Topics of the workshops

Workshops are not provided within the discipline.

Topics of the laboratory classes

Topic 1. Solving a multicriteria problem using Carlin's theorem
Topic 2. Solving a multicriteria problem using the third theorem
Topic 3. Solving a multicriteria problem by the method of constraints
Topic 4. Solving a multicriteria problem by the method of successive concessions
Topic 5. Solving a multicriteria problem using the method of sequential introduction of constraints

Self-study

Topic № 1. Problems of fuzzy mathematical programming.
1.1. The task of achieving a fuzzy defined goal (Bellman-Zade approach).
1.2. Classification of fuzzy mathematical programming problems.
1.3. Generalization of the fuzzy relationship of preference. The generalization principle.
1.4. The general problem of fuzzy mathematical programming and the method of its solution.
1.5. Transport problem in conditions of uncertainty.
Topic № 2. Multicriteria decision-making problems in conditions of uncertainty.
2.1. Multicriteria decision-making tasks in terms of certainty.
2.2. Multicriteria linear programming (LP) problems with fuzzy objective functions.
2.3. Multicriteria problem of LP with fuzzy parameters in the objective function.
2.4. Multicriteria nonlinear programming with fuzzy parameters.
Individual assignments are not provided in the curriculum.
Students are recommended with additional materials (videos, articles) for self-study and processing.

Course materials and recommended reading

Key literature

1. Petrov, E.G., Novozhilova, M.V., Grebennik, I.V. (2004). Methods and means of decision-making in socio-economic systems: Study guide. Kyiv: Technika.
2. Zaychenko, Y. P. (2014). Theory of decision-making: Textbook. Kyiv: NTUU "KPI".
3. Voloshyn, O. F. Mashchenko, S. O. (2010). Model and methods of decision-making: Study guide. Kyiv: Kyiv University.
4. Bidyuk PP, Tymoshchuk OL, Kovalenko AE, Korshevnyuk LO (2022). Systems and methods of decision support: Study guide. Kyiv: Igor Sikorsky Kyiv Polytechnic Institute.
5. Gnatienko, GM, Snityuk, VE (2008). Expert decision-making technologies: Monograph Kyiv: Maclauth.
6. Katrenko, A. V., Pasichnyk, V. V. (2013). Decision-making: theory and practice. - Lviv: "New World - 2000", - 447 p.
7. Godlevsky MD, Volovshchikov VY, Kozulya MM (2023). Methodical instructions for laboratory classes in the course "Theory of decision-making". Kharkiv: NTU "KHPI".
8. Butko, MP, Butko, IM, Mashchenko, VP (2019). Theory of decision making: Textbook. Kyiv: Center for Educational Literature.
9. Negray, M. V., Tuzhyk, K. L. (2018). Theory of decision making: Study guide. Kyiv: Center for Educational Literature.

Additional literature

1. Larichev, David L. Olson (2013). Multiple Criteria Analysis in Strategic Siting Problems. Springer Science & Business Media.
2. V. V. Kolbin (2003). Decision Making and Programming. World Scientific.
3. Peter C. Fishburn (1979). Utility Theory for Decision Making / P.C.Fishburn. Krieger.
4. Totsenko, V.G. (2004). Expert systems of diagnostics and decision support. K.: Naukova Dumka.
5. Kryuchkovskiy, S. S., Petrov, E. R., Sokolova, N. A., Khodakov, S. E. (2011). Introspective analysis. Methods and means of expert evaluation. Kharkiv: Hryn D. S.
6. Petrovsky, A. (2008). Group verbal decision analysis. In Encyclopedia of Decision Making and Decision Support Technologies (pp. 418-425). IGI Global.
7. Zgurovsky, M.Z., Zaychenko, Y.P. (2011). Models and methods of decision making in fuzzy conditions. K.: Naukova Dumka.
8. Thomas L. Saaty (1994). Fundamentals of Decision Making and Priority Theory with the Analytic Hierarchy Process. RWS Publications.

Assessment and grading

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

100% final assessment in the form of an exam (40%) and a current assessment (60%).
40% exam: semester exam in accordance with the schedule of the educational process
60% current assessment:
- 40% assessment of tasks in laboratory works;
- 20% intermediate control.

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	08.06.2023	Head of the department Ihor HAMAIUN
	08.06.2023	Guarantor of the educational program Uliya LITVINOVA