# DECISION MAKING THEORY

COURSE SYLLABUS

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| **Code and name of specialty** | 122 «Computer Science» | **Institute / faculty** | Faculty of Computer Science and Software Engineering |
| **Program name** | «Computer Science and Intelligent Systems» | **Department** | Software Engineering and Management Information Technologies |
| **Type of program** | Educational and Professional | **Language of instruction** | Ukrainian, English |

## LECTURER


**Full name, *e-mail*** — **GODLEVSKYI Mikhail,** *god_asu@kpi.kharkov.ua*

**Doctor of Technical Sciences, Professor, Head of the Department of Software Engineering and Information Technology Management, 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.**


## GENERAL DESCRIPTION OF THE COURSE

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| **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** | 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". |
| **Types of classes and control** | Lectures, laboratory classes, consultations. Final control - exam. |
| **Terms** | 7 |

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| **Student workload (credits) / Type of course** | 4 / Mandatory | **Lectures (hours)** | 48 | **Workshops (hours)** | 16 | **Self-study (hours)** | 56 |

| (Mandatory /elective) | | | | | | | |
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| **Programme competencies** | GC1. Ability to abstract thinking, analysis and synthesis.<br>GC2. Ability to apply knowledge in practical situations.<br>GC3. Knowledge and understanding of the subject area and understanding of professional activity.<br>GC6. Ability to learn and master modern knowledge.<br>GC7. Ability to search, process and analyze information from various sources.<br>GC9. Ability to work in team.<br>GC11. Ability to make justified decisions.<br>GC12. Ability to evaluate and ensure the quality of performed work.<br>GC13. Ability to act being based on ethical considerations.<br>PC1. Ability to mathematically formulate and study continuous and discrete mathematical models, justify the choice of methods and approaches for solving theoretical and applied problems in the field of computer science, analysis and interpretation.<br>PC5. Ability to provide a formalized description of operations research tasks in organizational, technical, and socio-economic systems for different purposes, to determine their optimal solutions, to build optimal management models taking into account changes in the economic situation, to optimize management processes in different systems and hierarchies.<br>PC6. Ability to think systematically, apply the systems analysis methodology to study complex problems of different nature, methods of formalization and solution of system problems with conflicting goals, uncertainties, and risks.<br>PC7. Ability to apply the theoretical and practical basics of methodology and modeling technology to study the characteristics and behavior of complex objects and systems, to conduct computational experiments with processing and analysis of results.<br>PC18. Ability to apply modern methods of decision-making theory, including methods of ranking, formation, and coordination of collective expert assessments, multi-criteria optimization etc., to build intelligent management systems. |

| **Learning outcomes** | **Teaching and learning methods** | **Forms of assessment (continuous assessment CAS, final assessment FAS)** |
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| PLO2. Use a modern mathematical apparatus of continuous and discrete analysis, linear algebra, analytical geometry, in professional activities to solve problems of theoretical and applied nature in the design and implementation of informatization objects. | Interactive lectures with presentations, discussions, practical classes, method of feedback from students, problem-based learning | Written individual assignments for laboratory work (CAS), assessment of knowledge in laboratory classes (CAS), rapid surveys (CAS), online tests (CAS), final / semester control in the form of a semester exam, according to the schedule of the educational process (FAS) |
| PLO7. Understand the principles of modelling organizational and technical systems and operations; use methods of operations research, solve single- and multicriteria optimization problems of linear, integer, nonlinear, stochastic programming. | | |
| PLO8. Use the methodology of system analysis of objects, processes, and | | |

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| systems for the tasks of analysis, prediction, management, and design of dynamic processes in macroeconomic, technical, technological, and financial objects. | | |
| PLO18. Apply modern methods of decision-making theory for the construction of intelligent management systems, including methods of ranking, formation, and coordination of collective expert assessments, multi-criteria optimization, and others. | | |

## ASSESSMENT AND GRADING

**Ranges of points corresponding to grades**

| Total score (points) for all types of learning activities | ECTS grading scale | The national grading scale |
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| 90-100 | A | excellent |
| 82-89 | B | good |
| 74-81 | C | |
| 64-73 | D | satisfactory |
| 60-63 | E | |
| 35-59 | FX | Unsatisfactory (with the exam retake option) |
| 0-34 | F | Unsatisfactory (with mandatory repetition of the course) |

**Allocation of grade points**

**100% Final assessment** as a result of Final exam (40%) та and Continuous assessment (60%).
**40% Final exam**
**60% Continuous assessment**

**Course policy**

Students are required to attend classes according to schedule and adhere to ethical behavior. In the absence of students will need to complete all tasks to compensate for missed classes. Participation in practical classes requires prior preparation and early processing of all necessary materials for productive discussions during the lesson. Written assignments must be submitted by the deadline.

## COURSE STRUCTURE AND CONTENT

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| **Theme 1 Lecture 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 | **Laboratory class 1** | Solving a multicriteria problem using Carlin's theorem | **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 |
| **Theme 2 Lecture 2, 3** | 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. | | | | |

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| **Theme 3 Lecture 4, 5** | 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. | | | | mathematical programming and the method of its solution.<br>1.5. Transport problem in conditions of uncertainty. |
| **Theme 4 Lecture 6** | Measurement and scaling of partial criteria. Scales: names, order, intervals, relations. Absolute scales. | **Laboratory class 2** | Solving a multicriteria problem using the third theorem | | |
| **Theme 5 Lecture 7** | Vector optimization based on a radical approach. Pareto and Slater sets. Theoretical and practical meaning of effective solutions. | | | | |
| **Theme 6 Lecture 8, 9** | 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. | **Laboratory class 3** | Solving a multicriteria problem by the method of constraints | | |
| **Theme 7 Lecture 10, 11** | 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 Lecture 12, 13** | 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. | **Laboratory class 4** | Solving a multicriteria problem by the method of successive concessions | | **Topic № 2. Multicriteria decision-making problems in conditions of uncertainty.**<br>2.1. Multicriteria decision-making tasks in terms of certainty.<br>2.2. Multicriteria linear programming (LP) problems with fuzzy objective functions.<br>2.3. Multicriteria problem of LP with fuzzy parameters in the objective function.<br>2.4. Multicriteria nonlinear programming with fuzzy parameters. |
| **Theme 9 Lecture 14, 15** | 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 Lecture 16, 17** | Decision support based on system optimization. The method of forming effective solutions. Classification of system optimization problems. System optimization algorithms. | | | | |
| **Theme 11 Lecture 18** | Saati pairwise comparison method. Examples of use. | **Laboratory class 5** | Solving a multicriteria problem using the method of sequential introduction of constraints | | |
| **Theme 12 Lecture 19,** | Solve poorly structured problems by analytical hierarchy. Hierarchies of priorities and justification | | | | |

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| **20** | of the method. Algorithm and practical implementations of the method. | | | | |
| **Theme 13 Lecture 21, 22** | Methodology of collective expert evaluation. Formation of an expert group. Generation of expert information Examination. Aggregation of expert judgments. | | | | |
| **Theme 14 Lecture 23, 24** | Information technologies of decision support systems (DSS). DSS structure. DSS actors. Examples of DSS. | | | | |

## RECOMMENDED READING

**Compulsory**


1. Петров Е. Г., Новожилова М. В., Гребеннік. І. В. (2004) Методи і засоби прийняття рішень у соціально-економічних системах. Київ: Техніка.
2. Зайченко Ю. П. (2014) Теорія прийняття рішень. Підручник. Київ: НТУУ «КПІ».
3. Волошин О. Ф., Мащенко С. О. (2010) Модель і методи прийняття рішень. Київ: «Київський університет».
4. Ситник В. Ф. Ситник. В. Ф. (2004) Системи підтримки прийняття рішень.Київ: КНЕУ.
4. Гнатієнко Г. М., Снитюк В. Є. (2008) Експертні технології прийняття рішень. Монографія Київ: ТОВ «Маклаут».
5. Катренко А. В., Пасічник В. В. Рубін. Е.Ю. (2013) Прийняття рішень: теорія та практика Львів: «Новий Світ – 2000»
6. Годлевський М.Д., Воловщиков В.Ю., (2009) Методичні вказівки для студентів до лабораторних занять з курсу «Теорія прийняття рішень», Харків: НТУ «ХПІ»
7. Бутко М. П. Бутко І. М., Мащенко В. П. (2019) Теороія прийняття рішень. Київ: Центр навчальної літератури.
8. Негрей М. В., Тужик К. Л. (2018) Теорія прийняття рішень. К: Центр навчальної літератури.


**Recommended**


9. Ларичев О. И. (1979) Наука и искусство принятия решений Москва: Наука.
10. Подиновский В. В., Ногин В. Д. (1982) Парето-оптимальные решения многокритериальных задач. М: «Наука».
10. Фишберн П. С., Фишберн. П. С. (1977) Теория полезности для принятия решений Москва : Наука.
11. Тоценко В. Г. (2004) Експертні системи діагностики і підтримки рішень Київ: «Наукова думка»
12. Крючковский В.В., Петров Э.Г., Соколова Н.А., Ходаков. В.Е., Гринь Д.С., (2011) Интроспективный анализ. Методы и средства экспертного оценивания Херсон:
10. Михалевич В. С., Волкович В. Л. (1993) Концепция построения основных функциональных подсистем системы поддержки принятия решений. Автоматика. №5. С. 3-13.
11. Моисеенко В. В., Яцкевич В. В.(1997) Системная оптимизация как обобщение оптимизации классической. Кибернетика и системный анализ. — № 3. – С. 135–139.
12. Глушков В. М. (1980) О системной оптимизации // Кибернетика. № 5. С. 89–90.
13. Петровский А. Б. (2009) Теория принятия решений / Москва : Академия.
14. Згуровский М. З., Зайченко Ю. П. (2011) Модели и методы принятии решений в нечетких условиях, Київ: Наукова думка.
15. Саати Т. (1993) Принятие решения. Метод анализа иерархий Москва: Радио и связь.


## Academic integrity

The student must adhere to the Code of Ethics of Academic Relations and Integrity of NTU "KhPI": to show discipline, politeness, friendliness, honesty, responsibility

The content of this syllabus is consistent with the course program.