Syllabus
Course Program

Intelligent Management Systems and Knowledge Bases

Specialty
122 – Computer Science

Institute
Institute of Computer Science and Information Technology

Educational program
Computer Science and Intelligent Systems

Department
Software Engineering and Management Intelligent Technologies (321)

Level of education
Bachelor's level

Course type
Special (professional), Mandatory

Semester
5

Language of instruction
English, Ukrainian

Lecturers and course developers

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Doctor of Technical Sciences, Professor, Professor of the Department of Software Engineering and Information Technologies of NTU "KhPI"

Prepared and published more than 100 scientific and educational works (Google Scholar: https://scholar.google.com/citations?user=ZEe2GlcAAAAJ; ORCID https://orcid.org/0000-0003-2938-4215; Scopus: https://www.scopus.com/authid/detail.uri?authorId=57541344600).
More about the lecturer on the department's website

General information

Summary

The course is an academic discipline from the cycle of professional compulsory training in the specialty 122 "Computer Science". It is taught in the eighth semester in the amount of 150 hours (5 ECTS credits), including: lectures - 20 hours, laboratory classes - 30 hours, independent work - 100 hours. The course includes laboratory work and a course project. The course ends with a test.

Course objectives and goals

To acquaint students with the basic approaches to solving intellectual problems, to form the mastery of the basic principles of construction and functioning of intellectual systems, to develop skills and abilities to choose methods for solving typical intellectual problems, to familiarize with the basic principles of construction and functioning of intellectual control systems.

Format of classes

Lectures, laboratory work, course project, independent work, consultations. The final control is a test.

Competencies

GC1. Ability to think abstractly, analyze and synthesize.
GC2. Ability to apply knowledge in practical situations.
GC3. Knowledge and understanding of the subject area and understanding of professional activities.

GC6. Ability to learn and master modern knowledge.
GC7. Ability to search, process and analyze information from various sources.
PC2. Ability to identify statistical regularities of non-deterministic phenomena, apply methods of computational intelligence, in particular statistical, neural network and fuzzy data processing, machine learning and genetic programming methods, etc.
PC3. Ability to think logically, build logical conclusions, use formal languages and models of algorithmic computing, design, develop and analyze algorithms, evaluate their effectiveness and complexity, solvability and intractability of algorithmic problems for adequate modeling of subject areas and creation of software and information systems.
PC5. Ability to carry out a formalized description of the tasks of researching operations in organizational, technical and socio-economic systems for various purposes, to determine their optimal solutions, to build models of optimal management taking into account changes in the economic situation, to optimize management processes in systems of various purposes and hierarchy levels.
PC6. Ability to think systematically, apply the methodology of system analysis to study complex problems of different nature, methods of formalizing and solving systemic problems with conflicting goals, uncertainties and risks.
PC7. Ability to apply the theoretical and practical foundations of modeling methodology and technology to study the characteristics and behavior of complex objects and systems, to conduct computational experiments with processing and analysis of results.
PC9. Ability to implement a multi-level computing model based on client-server architecture, including databases, knowledge and data warehouses, to perform distributed processing of large data sets on clusters of standard servers to meet the computing needs of users, including cloud services.
PC11. Ability to intelligently analyze data based on computational intelligence methods, including large and poorly structured data, their operational processing and visualization of analysis results in the process of solving applied problems.
PC17. Ability to apply the theoretical and practical foundations of modern management theory of complex organizational, technical and socio-economic systems to build intelligent management systems, to use modern information processing technologies and methods of computational intelligence in the design of intelligent systems.

Learning outcomes

PLO1. To apply knowledge of the basic forms and laws of abstract and logical thinking, the basics of the methodology of scientific knowledge, forms and methods of extracting, analyzing, processing and synthesizing information in the subject area of computer science.
PLO3. To use knowledge of the laws of random phenomena, their properties and operations on them, models of random processes and modern software environments to solve problems of statistical data processing and build predictive models.
PLO4. To use methods of computational intelligence, machine learning, neural network and fuzzy data processing, genetic and evolutionary programming to solve problems of recognition, forecasting, classification, identification of control objects, etc.
PLO7. Understand the principles of modeling organizational and technical systems and operations; use methods of researching operations, solving single and multi-criteria optimization problems of linear, integer, nonlinear, stochastic programming.
PLO8. To use the methodology of system analysis of objects, processes and systems for the tasks of analysis, forecasting, management and design of dynamic processes in macroeconomic, technical, technological and financial objects.
PLO10. To use tools for developing client-server applications, design conceptual, logical and physical models of databases, develop and optimize queries to them, create distributed databases, data warehouses and showcases, knowledge bases, including cloud services, using web programming languages.
PLO12. Apply methods and algorithms of computational intelligence and data mining in the tasks of classification, forecasting, cluster analysis, search for associative rules using software tools to support multivariate data analysis based on DataMining, TextMining, WebMining technologies.
PLO17. Apply theoretical and practical foundations of modern management theory to build intelligent control systems, design intelligent systems using modern information processing technologies and methods of computational intelligence.

PLO19. To create intelligent management systems using methods of mathematical modeling and analysis of complex systems, methods of modeling and analysis of business processes, information technology management of business systems.
PLO20. Develop the architecture of software systems and their individual components in the construction of intelligent control systems in various industries, as well as manage the life cycle processes of software of intelligent control systems.

Student workload

The total volume of the course is 150 hours (5 ECTS credits): lectures - 20 hours, laboratory classes - 30 hours, self-study - 100 hours.

Course prerequisites

The basis for studying the discipline is the general mathematical training of students and the content of the disciplines "Operations Research", "Decision Theory", as well as the use of mathematical packages.

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

Teaching and learning methods:
interactive lectures with presentations, discussions, laboratory classes, teamwork, case studies, student feedback, and problem-based learning. Sprints, project and teamwork, peer-to-peer, and case studies have been developed for students at the Innovation Campus.
Forms of assessment:
written individual assignments for laboratory work (CAS), assessment of knowledge in laboratory classes (CAS), express surveys (CAS), final/semester control in the form of a semester exam, in accordance with the schedule of the educational process (FAS). For students at the Innovation Campus, the learning management system LMS GREEN is used for assessment.

Program of the course

Topics of the lectures

Topic 1: Definition and history of occurrence. Examples of intellectual tasks. General characteristics of intelligent systems. Characteristics of algorithmic and declarative approaches. Quasi-algorithms and the main sources of quasi-algorithmicity
Topic 2. The purpose and objectives of object management. The concept of a control object. Principles of building control systems. Architecture of control systems
Topic 3. Modeling of control objects. General principles of modeling control systems. General structures of control systems. Modeling of regulators. Modeling of control systems with different regulators.
Topic 4. Definition of an intelligent system. Typical scheme of functioning of an intelligent system Representation of knowledge in intelligent systems.
Topic 5. Approaches to knowledge representation. Verbal and deductive definition of knowledge. Expert systems. Data and knowledge. Properties and models of knowledge.
Topic 6. Logical models and the method of resolutions.
Automatic theorem proving and the principle of resolutions. The concept of logic programming.
Topic 7. Production models. General characteristics. The case of fuzzy productive rules. Fuzzy sets.
Topic 8. Principles of training and tuning of intelligent control systems. Optimization of control system parameters using genetic algorithms.
Topic 9: Intelligent control systems using fuzzy logic. Features of fuzzy logic inference in the tasks of controlling complex dynamic objects.
Topic 10. General principles of building fuzzy algorithms for controlling dynamic objects. The procedure for synthesizing fuzzy controllers.

Topics of the workshops

Workshops are not provided within the discipline.

Topics of the laboratory classes

Topic 1: Implementation of the traveling salesman problem using the ant algorithm
Topic 2. Automated tuning of the PID controller using the Simulink software package
Topic 3. Development of elements of an expert system that implements direct and reverse output
Topic 4. Formation of a set of input and output linguistic variables of a fuzzy control system using Fuzzy Logic Toolbox
Topic 5. Building a fuzzy control system using Fuzzy Logic Toolbox

Self-study

Topics for self-study:
Model of the traveling salesman problem.
Swarm optimization algorithms.
Sensor information processing and natural language interface in intelligent control systems.
Hybrid intelligent control systems.
Principles of construction of neuro-fuzzy controllers.
Soft computing.
Computational intelligence.
Frames.
The relationship between semantic networks and frames.
Intelligent robots.
Intelligent systems in modern robotics.
Intelligent systems of virtual reality.
Fundamentals of cognitive modeling.
Software of cognitive modeling procedures.
Construction and stability analysis of fuzzy cognitive maps.
Application of fuzzy cognitive maps for decision making.
Course project:
The course project is provided in the curriculum.
During the course project, it is necessary to design and implement a graphical user interface program that allows you to study the composition and principles of operation of the logical inference mechanism of a product-type expert system.
The topic of the course project: development of a graphical user interface application program for a product-type expert system.
Evaluation is based on the following criteria:
1) understanding, degree of mastery of the theory and methodology of the problems under consideration;
2) degree of mastery of the work material;
3) implementation of a software product on the topic of the course work;
4) testing and demonstration of a graphical user interface program that allows you to solve a specific data processing task;
5) logic, structure, style of presentation of material in written works and in classroom presentations, ability to justify one's position, generalize information and draw conclusions.
The grade of "excellent" is assigned if the student's completed assignment or oral response meets all five of these criteria.
The absence of a particular component reduces the grade by the corresponding number of points.
The assessment pays attention to the quality and independence of the student's work, as well as the timeliness of submitting the completed assignments to the teacher (according to the schedule of the educational process). If any of the requirements are not met, the grade will be lowered.

Course materials and recommended reading

Key literature

1. Subbotin, S. O. (2018). Representation and processing of knowledge in artificial intelligence and decision support systems. Zaporizhzhia: ZNTU.
2. Yaroshchuk LD (2019). Intelligent control systems. Expert systems - basics of design and application in automation systems. Igor Sikorsky Kyiv Polytechnic Institute.
3. Velychko, O. M., Gordienko, T. B. (2022). Intelligent information systems: structure and application. Aldi+.
4. Eremeev, IS, Guida, OG (2021). Intelligent systems for preparing decisions Helvetica.
5. Ertel W. (2017). Introduction to Artificial Intelligence Springer. International Publishing AG.
6. Nesterenko O.V., Kovtunets O.V., Falovsky O.O. (2017) Intelligent systems and technologies. Introductory course: Study guide. Kyiv: National Academy of Management.

Additional literature

1. Soroka, P. M., Kharchenko, V. V., Kharchenko, G. A. (2019). Information systems and technologies in organization management: a textbook. Kyiv: CP "Kompoprint".
2. Kotsovskyi, V. M. (2019). Intelligent information systems. Uzhhorod.
3. Zvenigorodsky, A. S., Katkov, Y. I. (2019). Methodical instructions for practical classes in the discipline "Artificial Intelligence" for students of the specialty: 121 Software Engineering, 123 Computer Engineering, 124 System Analysis, 125 Cybersecurity, 126 Information Systems and Technologies of all forms of education. Kyiv: DUT.
4. Zhukovskyi, V. V. (2016).Methodical instructions for performing laboratory work in the discipline "Fundamentals of designing artificial intelligence systems and pattern recognition" for students majoring in 113 "Applied Mathematics", 122 "Computer Science and Information Technology". Rivne: NUWHP.
5. Hlybovets, M. M., Oletskyi, O. V. (2017). Artificial intelligence systems: Study guide. Kyiv: KM Academy.

Assessment and grading

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

100% final assessment in the form of a test (20%) and a current assessment (80%).
20% credit;
80% current assessment:
- 70% evaluation of tasks on laboratory work;
- 10% course project.

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 Andrii KOPP