

# MODELING TECHNOLOGIES OF INTELLIGENT SYSTEMS

## COURSE SYLLABUS

<b>Code and name of specialty</b>	121 Software Engineering 122-Computer Science 126-Information Systems and technologies	<b>Institute / faculty</b>	Faculty of Computer Science and Software Engineering
<b>Program name</b>	Software Engineering  Computer Science and Intelligent Systems  Information Systems Software	<b>Department</b>	Software Engineering and Management Information Technologies
<b>Type of program</b>	Educational and Professional	<b>Language of instruction</b>	Ukrainian, English

## LECTURER

**Name and surname, email** Karina Melnyk, Karina.Melnyk@khpi.edu.ua



**Ph.D., Associate Professor, Associate Professor of Software Engineering and Information Technology Management. Author (co-author) of more than 60 publications, 5 collective monographs, 8 articles in publications indexed in Scopus and Web of Science. (h-index = 5, i10-index = 1 in Google Scholar -<https://scholar.google.com/citations?user=xCU7GMgAAAAJ&hl=ru>; ORCID ID <https://orcid.org/0000-0001-9642-5414>; Scopus Author ID <https://www.scopus.com/authid/detail.uri?authorId=57195074119>).**

**Leading lecturer of the courses:** Basics of Software Engineering (Bachelors) (in English), Methods of Empirical Information Processing (Bachelors) (in English and Ukrainian), Basics of Intelligent Systems Design (Masters) (in English and Ukrainian)

## GENERAL DESCRIPTION OF THE COURSE

<b>Summary</b>	The discipline "MODELING TECHNOLOGIES OF INTELLIGENT SYSTEMS" is an academic discipline from the cycle of profile selective training in the specialty 121 "Software Engineering". It is taught in the seventh semester in the amount of 120 hours (4 ECTS credits), in particular: lectures - 16 hours, laboratory - 16 hours, independent work - 88 hours. The course provides two content modules and one module test. The discipline ends with a test.
<b>Course objectives</b>	Teaching students the technology of modeling intelligent systems, allowing to form knowledge and competencies in the field of application of intelligent systems to solve problems of automated business process management.
<b>Types of classes and control</b>	Lectures, laboratory classes. Continuous assessment – laboratory works, intermediate modular assessment, course work. Final assessment – test.
<b>Term</b>	7

**121***General competencies*

GC01. Ability to abstract thinking, analysis and synthesis.

GC 02. Ability to apply knowledge in practical situations.

GC 05. Ability to learn and master modern knowledge.

GC 06. Ability to search, process and analyze information from various sources.

*Professional competencies of the specialty*

PC13. Ability to identify, classify and formulate software requirements.

PC19. Knowledge of information data models, the ability to create software for data storage, retrieval and processing.

PC20. Ability to apply fundamental and interdisciplinary knowledge to successfully solve software engineering problems.

PC26. Ability to algorithmic and logical thinking.

**122***General competencies*

GC1. Ability to abstract thinking, analysis and synthesis.

GC2. Ability to apply knowledge in practical situations.

GC3. Knowledge and understanding of the subject area and understanding of professional activity.

GC6. Ability to learn and master modern knowledge.

GC7. Ability to search, process and analyze information from various sources.

*Professional competencies of the specialty*

PC2. Ability to detect statistical patterns of non-deterministic phenomena, the use of computational intelligence methods, including 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 calculations, design, develop and analyze algorithms, evaluate their efficiency and complexity, solvability and unsolvability of algorithmic problems for adequate modelling of subject areas and creation of software and information systems.

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.

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.

PC7. Ability to apply the theoretical and practical basics of methodology and modelling technology to study the characteristics and behavior of complex objects and systems, to conduct computational experiments with processing and analysis of results.

PC11. Ability to conduct intelligent data analysis based on methods of computational intelligence, including large and poorly structured data, their operational processing and visualization of analysis results in the process of solving applied problems.

PC15. Ability to analyze and perform functional modelling of business processes, construction and practical application of functional models of organizational, economic, and production-technical systems, methods of risk assessment of their design.

PC17. Ability to apply the theoretical and practical basics of modern management theory for complex organizational, technical and socio-economic systems to build intelligent management systems, in the process of designing intelligent systems to use modern information processing technologies and methods of computational intelligence.

PC19. Ability to comprehensively use for the creation of intelligent management systems methods of mathematical modelling and analysis of complex

systems, methods of modelling and analysis of business processes, information technologies for the management of business systems.  
 PC20. Ability to develop the architecture of software systems and their particular components during the design of intelligent management systems in various fields, to manage the life cycle of intelligent management systems software.

**126**

*General competencies*

- GC 1. Ability to abstract thinking, analysis and synthesis.
- GC 2. Ability to apply knowledge in practical situations.
- GC 3. Ability to understand the subject area and professional activity.
- GC 5. Ability to learn and master modern knowledge.
- GC 6. Ability to search, process and summarize information from various sources.

*Professional competencies of the specialty*

- PC 1. Ability to analyze the object of design or operation and its subject area.
- PC 2. Ability to apply standards in the field of information systems and technologies in the development of functional profiles, construction and integration of systems, products, services and infrastructure elements of the organization.
- PC 4. Ability to design, develop and use tools for the implementation of information systems, technologies and infocommunications (methodological, informational, algorithmic, technical, software and others).
- PC 6. Ability to use modern information systems and technologies (production, decision support, data mining, etc.), cybersecurity techniques and techniques in the performance of functional tasks and responsibilities.
- PC 11. Ability to analyze, synthesize and optimize information systems and technologies using mathematical models and methods.
- PC 13. Ability to perform computational experiments, compare the results of experimental data and solutions.

Learning outcomes	Teaching and learning methods	Forms of assessment (continuous assessment CAS, final assessment FAS)
<b>121</b>		
PO01. Analyze, purposefully search for and select the necessary information and reference resources and knowledge to solve professional problems, taking into account modern advances in science and technology.	Interactive lectures with presentations, discussions, practical classes, teamwork, case method, research, project training	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)
PO05. Know and apply relevant mathematical concepts, methods of domain, system and object-oriented analysis and mathematical modelling for software development.		
PO09. Know and be able to use methods and tools for collecting, formulating and analyzing software requirements.		
PO10. Conduct a pre-project survey of the subject area, systematic analysis of the design object.		
PO11. Choose source data for design, guided by formal methods of describing requirements and modeling.		
PO23. Be able to document and present the results of software development.		

PLO1. Apply knowledge of the fundamental forms and laws of abstract-logical thinking, the basics of the methodology of scientific knowledge, forms and methods of extraction, analysis, processing, and synthesis of information in the subject area of computer science.

PLO3. Use knowledge of the laws of random phenomena, their properties and operations with them, models of random processes, and modern software environments to solve problems of statistical data processing and construction of predictive models.

PLO4. Use methods of computational intelligence, machine learning, neural network, and fuzzy data processing, genetic and evolutionary programming to solve problems of recognition, prediction, classification, identification of management objects, etc.

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 systems for the tasks of analysis, prediction, management, and design of dynamic processes in macroeconomic, technical, technological, and financial objects.

PLO12. Apply methods and algorithms of computational intelligence and intelligent data analysis in the tasks of classification, prediction, cluster analysis, search for associative rules using software tools to support multidimensional data analysis based on technologies DataMining, TextMining, WebMining.

PLO14. Apply knowledge of methodology and CASE tools for designing complex systems, methods of structural analysis of systems, object-oriented design methodology in the development and study of functional models of organizational-economic and production-technical systems.

Interactive lectures with presentations, discussions, practical classes, teamwork, case method, research, project training

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)

PLO17. Apply for the construction of intelligent management systems theoretical and practical foundations of modern management theory, design intelligent systems using modern information processing technologies and methods of computational intelligence.		
PLO19. Create intelligent management systems using methods of mathematical modelling and analysis of complex systems, methods of modelling and analysis of business processes, information technologies for the management of business systems.		
PLO20. Develop the architecture of software systems and their particular components during the construction of intelligent management systems in various fields, as well as manage the life cycle of intelligent management systems software.		
<b>126</b>		
PLO 2. Apply knowledge of basic and natural sciences, systems analysis and modeling technologies, standard algorithms and discrete analysis in solving problems of design and use of information systems and technologies.	Interactive lectures with presentations, discussions, practical classes, teamwork, case method, research, project training	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)
PLO 6. Demonstrate knowledge of the current level of information systems technology, practical skills of programming and use of applied and specialized computer systems and environments for their implementation in professional activities		

### ASSESSMENT AND GRADING

Range s of points corres pondi ng to grades	core (points) for all types of learning activities	ECTS grading scale	The national grading scale	Allocation of grade points
	90-100	A	excellent	
	82-89	B	good	
	74-81	C	satisfactory	
	64-73	D	Unsatisfactory (with the exam retake option)	
	60-63	E	Unsatisfactory (with mandatory repetition of the course)	
	35-59	FX	Unsatisfactory (with mandatory repetition of the course)	
	0-34	F	Unsatisfactory (with mandatory repetition of the course)	

**100% Final assessment** as a result of Final exam (30%) and Continuous assessment (70%).  
**30% Final exam**  
**70% Continuous assessment:**

- 40% of assessment of tasks in laboratory works;
- 30% intermediate control (2 modular control works)

**Course policy** Students must attend all classes according to the study schedule and adhere to the norms of academic ethics. To study the course, students need to have their personal computer and (or) use computers of the computer center at the department. Students must work with compulsory and recommended reading, including Internet resources. Students must complete and submit all laboratory works during the semester in which the course is taught, before the examination session. The final assessment is not carried out without the personal presence of students.

COURSE STRUCTURE AND CONTENT						
Topic 1	Basic concepts and definitions of intelligent systems (IS)			Self-study	Examples of modern IP. Principles of organization of subsystems of logical inference	
Topic 2	Data and knowledge				Problems of developing knowledge-based systems.	
Topic 3	Output management in production systems	Laboratory work 1	Development of IP based on the production base of rules		Direct and reverse chain of reasoning. Resolution method.	
Topic 4	Representation of knowledge on semantic networks	Laboratory work 2	Design and modeling of IP using semantic networks		Logical conclusion in semantic networks. Structure and mechanism of IP functioning on semantic networks.	
Topic 5	Representation of knowledge with the help of frames	Laboratory work 3	Using frames to model the subject area		Structure of IS with representation of knowledge on frames. Features of implementation.	
Topic 6	Fuzzy modeling methodology	Laboratory work 4	Implementation of IP using fuzzy logic algorithms		Fuzzy inference algorithms. Methods of clarity.	
Topic 7	Artificial neural networks	Laboratory work 5	Development of IP based on artificial neural networks		Training of single-layer and special NM. Multilayer nonlinear NM.	

**RECOMMENDED READING**

<b>Compulsory</b>	1. Gupta, I., Nagpal, G. (2020). Artificial Intelligence and Expert Systems. <i>Stylus Publishing</i> . LLC, 412 p. 2. Tasso, C., Guida G. (2014). Topics in Expert System Design: Methodologies and Tools. <i>Elsevier</i> , 447 p. 3. F. Martin McNeill, Ellen. (2014). Thro Fuzzy Logic: A Practical Approach. <i>Academic Press</i> , 312 p. 4. Subana Shanmuganathan, Sandhya Samarasinghe. (2016). Artificial Neural Network Modelling. <i>Springer</i> , 472 p. 5. Gerardus Blokdyk. (2020). Semantic Network a Complete Guide. <i>Emereo Pty Limited</i> , 304 p. 6. Richard L Epstein. (2018). Predicate Logic. <i>Advanced Reasoning Forum</i> , 428 p. 7. Manhattan Prep. (2020). LSAT Logical Reasoning. <i>Simon and Schuster</i> , 600 p.	<b>Recommended</b>	8. Richard E. Neapolitan, Xia Jiang. (2018). Artificial Intelligence: With an Introduction to Machine Learning, Second Edition. <i>CRC Press</i> , 480 p. 9. Perez C. (2019). DEEP Learning Using Matlab. Neural Network APPLICATIONS. <i>Lulu Press. Inc.</i> 10. Timothy Williamson. (2018). Doing Philosophy: From Common Curiosity to Logical Reasoning. <i>Oxford University Press</i> , 192 p.
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**Academic integrity**

Graduate students are expected to adhere to the Code of Ethics of Academic Relations and Integrity” of NTU “KhPI”.

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

