

MATHEMATICAL MODELLING AND SYSTEM ANALYSIS

COURSE SYLLABUS

Code and name of specialty	122 Computer Sciences	Institute	Faculty of Computer Sciences and Software Engineering
Program name	"Computer Sciences and Intelligent Systems"	Department	Software Engineering and Management Information Technologies
Type of program	Educational and Professional	Language of teaching	

LECTURER

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Doctor of Technical Sciences (05.13.06 - automated management systems and advanced information technologies), Professor of the Department of Software Engineering and Management Information Technologies. Work experience - since 1975. Author (co-author) of more than 120 scientific and educational publications (<https://www.scopus.com/authid/detail.uri?authorid=6506853631>; <https://orcid.org/0000-0003-2099-4658>). Main courses: "Fundamentals of Scientific Research" (lectures), "Mathematical Modelling and System Analysis" (lectures, workshops), "Experiment Planning" (lectures, workshops).

GENERAL DESCRIPTION OF THE COURSE

Summary	The course "Mathematical Modelling and System Analysis" is a discipline in the cycle of special mandatory training in the specialty 122 "Computer Sciences". It is taught in the seventh semester in the amount of 120 hours (4 ECTS credits), in particular: lectures - 16 hours, workshops - 16 hours, independent work - 88 hours. There are no individual tasks. The study of the discipline ends with a test.
Course objectives	Formation of students' necessary theoretical knowledge and practical skills of building mathematical models of complex systems, which are necessary to determine the properties of systems, the dynamics of their functioning and forecast their development.
Types of classes and control	Lectures, workshops. Continuous assessment - workshops, intermediary modular assessment. Final assessment - credit.
Term	7

Student workload (credits)/Type of course (mandatory/selective)	4 / Mandatory	Lectures (hours)	16	Workshops (hours)	16	Self-study (hours)	88
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Program competences	<p>GC 1. Ability to abstract thinking, analysis and synthesis</p> <p>GC 2. Ability to apply knowledge in practical situations</p> <p>GC 3. Knowledge and understanding of the subject area and professional activity</p> <p>GC 6. Ability to learn and master modern knowledge</p> <p>GC 7 Ability to search, process and analyze information from various sources</p> <p>SC 1. Ability to mathematically formulate and study continuous and discrete mathematical models, justify the choice of methods and approaches for solving theoretical and practical problems in the field of computer science, analysis and interpretation.</p>
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SC 3. Ability to think logically, build logical conclusions, use formal languages and models, algorithmic calculations, design, development and analysis of algorithms, evaluate their effectiveness and complexity, adequate modeling of subject areas and information systems.

SC 4. Ability to use modern methods of mathematical modeling of objects, processes, phenomena, to develop models and algorithms for numerical solution of mathematical modeling problems, to take into account the errors of approximate numerical solution of professional problems.

SC5. Ability to provide a formalized description of operations research tasks in organizational, technical and socio-economic systems for different purposes, determine their optimal solutions, build models of optimal management taking into account changes in the economic situation, optimize management processes in systems for different purposes and hierarchy.

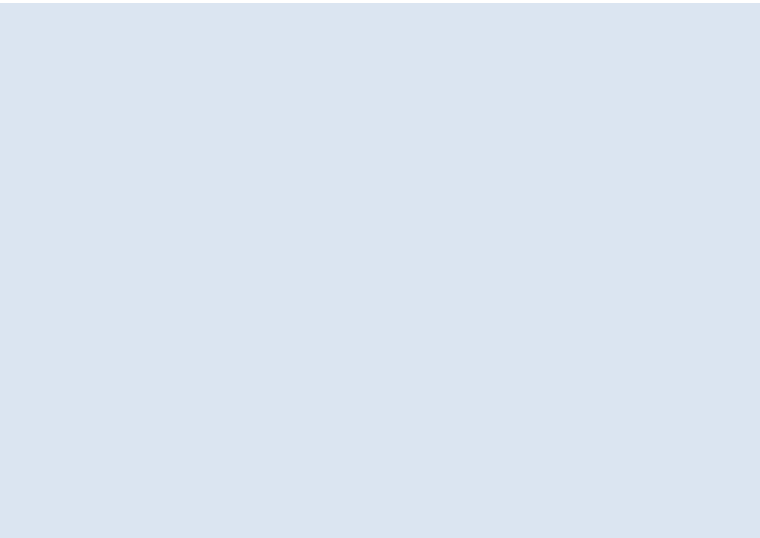
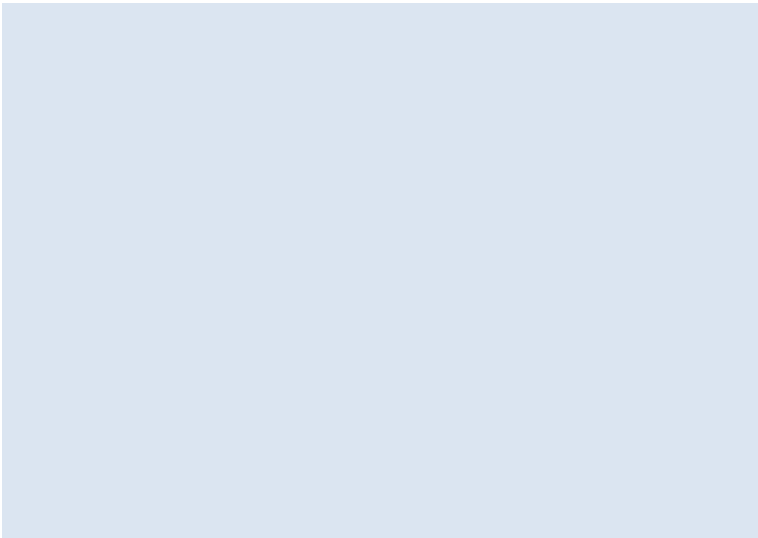
SC 6. Ability to systems thinking, application of systems analysis methodology to study complex problems of different nature, methods of formalization and solution of system problems that have conflicting goals, uncertainties and risks.

SC 18. Ability to apply modern methods of decision theory, including methods of ranking, formation and coordination of collective expert assessments, multi-criteria optimization and others to build intelligent management systems.

SC 19. Ability to comprehensively use for the creation of intelligent control systems methods of mathematical modeling and analysis of complex systems, methods of modeling and analysis of business processes, information technology management of business systems.

Learning outcomes	Teaching and learning methods	Forms of assessment (continuous assessment CAS, final assessment FAS)
<p>PLO 1. Apply knowledge of the basic 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</p> <p>PLO 2. 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 of informatization objects</p> <p>PLO 6. Use methods of numerical differentiation and integration of functions, solution of ordinary differential and integral equations, features of numerical methods and possibilities of their adaptation to engineering problems, have skills of software implementation of numerical methods</p> <p>PLO 7. Understand the principles of modeling of organizational and technical systems and operations; use operations research methods; solving single and multicriteria problems of mathematical programming</p> <p>PLO 8. Use the methodology of system analysis of objects, processes and systems for the tasks</p>	<p>Problem lecture "Modern problems of modelling complex systems".</p> <p>Mini-lecture "Analysis of requirements for models of complex systems".</p> <p>Mini-lecture "Problems of construction and use of simulation models".</p> <p>Case study "Examples of mathematical modelling of real objects".</p> <p>Work in small groups during workshop.</p>	<p>Continuous assessment CAS: Assessment of students' work in the process of workshops Intermediary modular control</p> <p>Final evaluation FAS: Credit</p>

of analysis, forecasting, management and design of dynamic processes in macroeconomic, technical, technological and financial objects
 PLO 18. Apply for the construction of intelligent management systems modern methods of decision theory, in particular methods of ranking, formation and coordination of collective expert assessments, multicriteria optimization and others
 PLO 19. 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



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		
	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)	

100% Final assessment as a result of Final credit (30%) and Continuous assessment (70%).
30% Final credit: ...
70% Continuous assessment: ...
 Module №1 (10%)
 Module №2 (20%)
 Workshop (40%)
 Workshop №1 (10%)
 Workshop №2 (10%)
 Workshop №3 (10%)
 Workshop №4 (10%)

Course policy The student is required to attend all classes according to the curriculum and adhere to the norms of academic ethics. To study the discipline you need to have your own personal computer and/or use the computers of the computer center of the department. The student must work with required and additional literature, including information resources on the Internet. All workshops must be completed and submitted by the student during the semester in which the discipline is taught, before the examination session. Without the personal presence of the student the final assessment is not carried out.

COURSE STRUCTURE AND CONTENT

Topic 1	The concept of a mathematical model of a complex system and methods of implementing the process of its construction.	Workshop 1	Familiarization with the AnyLogic simulation environment	S e l f - s t u d y	Construction of models of complex systems taking into account the hierarchy of their structure. Problems of building aggregate models.
Topic 2	Analytical modelling of the main types of processes in complex systems	Workshop 2	Building models of system dynamics in the AnyLogic environment		Models of combination of elements of a complex system.
Topic 3	The essence of simulation and features of its use	Workshop 3	Construction of discrete-event models in the AnyLogic environment		The choice of simulation language at the stage of software implementation of the simulation model.
Topic 4	Statistical modelling in analytical and simulation models	Workshop 4	Building agent models in the AnyLogic environment.		Methods of processing and analysis of results of experiments with models of systems.

RECOMMENDED READING

Compulsory

1. Sovetov B.Ya. Yakovlev S.A. (1985) Systems modelling M.: Higher school
2. Sergienko I.V. (1988) (Mathematical models and methods for solving discrete optimization problems) Kiev : Naukova Dumka
3. Tomashevsky V. N. Zhdanova O. G. (2003) Simulation in GPSS environment. Moscow: Bestseller
4. Boev V.D., Sipchenko R.P. (2009) Computer simulation. Elements of Theory and Practice: A Textbook. St. Petersburg : BAC
5. Boev V.D., Kirik D.I., Sipchenko R.P. (2011) Computer Modeling: A Guide to Course and Diploma Design. St. Petersburg: BAC.
6. Hamaiun I.P., Cherednichenko O.Yu. (2015) Modeling of systems: textbook Kharkiv: Fact
7. Hamaiun IP, Kopp A.M., Yangolenko I. V., Liutenko, O.B. (2019) and others. Analysis and modeling of problem-oriented software systems: a textbook / Kharkiv: FOP Chernyak.

Recommended

1. Tabunshchik. G.V., Kapliencko T. I., Petrova. O. A. (2016) Design and modeling of software of MODERN information systems Textbook. manual Zaporozhye
2. Petrik M. R. Snail. O.Yu. (2015) Software modeling Scientific-methodical manual Ternopil: TNTU Publishing House.
3. Kiselyova M. V. (2009) Imitation modeling of systems in the environment of AnyLogic: educational and methodical manual Ekaterinburg: UDTU-UPI.
4. Osorgin A. E. (2015) AnyLogic 7. Laboratory workshop Samara: PGK.

INFORMATION RESOURCES ON THE INTERNET

5. Microsoft Academy: Analysis of requirements for automated information systems: [Electronic resource] Access mode: Retrieved from: <http://www.intuit.ru/studies/courses/2188/174/info>
6. Klevtsov S. I. Analysis and formation of requirements for software information systems for data collection and processing. Training manual [Electronic resource] - Access mode: Retrieved from http://rtf.sfedu.ru/!mps/umk/strdsngn_ch1.pdf
7. Design of information systems. Access mode: Retrieved from: https://sites.google.com/site/anisimovkhv/learning/pris/lecture/tema8/tema8_4
8. Grigorev I. AnyLogic for 3 days. Practical manual for simulation modeling Access mode: Retrieved from: <http://simulation.su/uploads/files/default/2017-uch-posob-grigoriev-anylogic.pdf>, 28.04.18.

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.