Syllabus
Course Program

Mathematical models and systems analysis

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
3

Language of instruction
English, Ukrainian

Lecturers and course developers

Ihor Hamaiun

Ihor.Hamaiun@khpi.edu.ua

Doctor of Technical Sciences (05.13.06 - automated management systems and advanced information technologies), Professor of the Department of Software Engineering and Management Intelligent 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).
More about the lecturer on the department's website

Oleksandr Shmatko

oleksandr.shmatko@khpi.edu.ua

PhD., Senior Lecturer, Ass. Professor of the Department of Software Engineering and Intelligence Technologies of NTU "KhPI"

Prepared and published more than 90 scientific and educational works Google Scholar: https://scholar.google.com/citations?user=Wyv6ESUAAAAJ
ORCID: https://orcid.org/0000-0002-2426
Scopus: https://www2.scopus.com/authid/detail.uri?authorId= 6602623478
More about the lecturer on the department's website

General information

Summary

The course "Mathematical Models and Systems Analysis" is a discipline in the cycle of special mandatory training in the specialty 121 "Software Engineering". It is taught in the seventh semester in the amount of 150 hours (5 ECTS credits), in particular: lectures - 32 hours, workshops - 32 hours, independent work - 86 hours. There are no individual tasks. The study of the discipline ends with a test.

Course objectives and goals

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.

Format of classes

Lectures, laboratory classes. Continuous assessment - workshops, intermediary modular assessment. Final assessment - credit.

Competencies

К01. Ability to think abstractly, analyze and synthesize.
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.
PLO10. Conduct a pre-project survey of the subject area, system analysis of the design object.
PLO11. Select input data for design, guided by formal methods of requirements description and modeling.

Student workload

The total volume of the course is 150 hours (5 ECTS credits): lectures - 32 hours, Workshops - 32 hours, self-study - 86 hours.

Course prerequisites

Higher mathematics
Fundamentals of computer science and artificial intelligence methods
Algorithmization and programming
Algorithms and data structures

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

Teaching and learning methods:
interactive lectures with presentations, discussions, workshops classes, teamwork, case method, student feedback, problem-based learning.
Forms of assessment:
written individual assignments for Workshops (CAS), assessment of knowledge in Workshops (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

Topic 1. The concept of a mathematical model of a complex system and methods of implementing the process of its construction.

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
Models of combination of elements of a complex system.
Topic 3. The essence of simulation and features of its use
The choice of simulation language at the stage of software implementation of the simulation model.
Topic 4. Statistical modelling in analytical and simulation models
Methods of processing and analysis of results of experiments with models of systems.

Topics of the workshops

Topic 1. Familiarization with the AnyLogic simulation environment
Topic 2. Building models of system dynamics in the AnyLogic environment
Topic 3. Construction of discrete-event models in the AnyLogic environment
Topic 4. Building agent models in the AnyLogic environment

Topics of the laboratory classes

Laboratory classes are not provided within the discipline.

Self-study

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. Zelenskyi K.H., Keith G.V., Chumachenko O.I. Computer modeling of systems. University "Ukraine", 2014. - 314 p.
2. Dubovoi V.M., Kvetny R.N., Mykhalyov O.I., Usov A.V. Modeling and optimization of systems. - Vinnytsia: PE TD "Edelweiss". 2017. - 804 p.
3. Pavlenko P.M., Filonenko S.F., Cherednikov O.M., Treytyak V.V. Mathematical modeling of systems and processes: teaching. guide/P.M. Pavlenko, S.F. Filonenko - K.: NAU. 2017. - 392 p.
4. Easter S.S. Modeling of systems. - K.: KPI. 2018. - 186 p.
5. Savchuk O.V. Modeling processes and systems. - K.: KPI.2021. - 220s.
6. Complex D.M. Modeling and optimization of objects and management systems. - K.: KPI. 2021. - 199 p.
7. Pasichnyk V.V., Vyklyuk Y.I., Kaminsky R.M. Modeling of complex systems. University "Ukraine". 2021. - 404 p.

Additional literature

1. Tabunshchik, G. V., Kaplienko, T. I., Petrova, O. A. (2016). Design and modeling of software of modern information systems: Education. manual Zaporizhzhia.
2. Petryk, M.R., Petryk O.Yu. (2015). Software modeling: Scientific method. manual Ternopil: Publishing House of TNTU.
3. Banerjee S. (2021). Mathematical Modeling: Models, Analysis and Applications. CRC Press.
4. Borshchev A. (2013). The Big Book of Simulation Modeling: Multimethod Modeling with AnyLogic. AnyLogic North America.
5. Educational information for Ukrainian students. [Electronic resource] - Access mode: http://ni.biz.ua/3/3_20/3_20563_analiz-trebovaniy-k-avtomatizirovannim-informatsionnim-sistemam.html
6. Lyushenko, L. A. Development and analysis of software requirements: Education. manual [Electronic resource] - Access mode: https://ela.kpi.ua/handle/123456789/38101
7. Business Process Model and Notation (BPMN), Version 2.0. Retrieved from. https://www.omg.org/spec/BPMN/2.0/PDF
8. How to learn AnyLogic. Retrieved from. https://www.anylogic.com/getting-started/

Assessment and grading

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

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%)

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