Numerical Methods

COURSE SYLLABUS

Code and name of specialty	122 – Computer Science	**Institute**	**Computer Sciences and Software Engineering**
Program name	Computer Science and intelligence systems	**Department**	Software Engineering and Management Information Technologies
Type of program	**Educational and Professional**	**Language of instruction**	**Ukrainian**

LECTURER

Nikulina Olena Mykolayivna Olena.Nikulina@khpi.edu.eu

Doctor of Technical Sciences, Associate Professor, Professor of Software Engineering and Management Information Technologies Department. Number of scientific and educational publications – 90. (h-index = 5, i10-index = 1 in Google Scholar - https://scholar.google.com/citations?hl=en&user=ZEe2GlcAAAAJ&view_op=list_works&sortby=title; ORCID ID-https://orcid.org/0000-0003-2938-4215, Scopus ID-57203114988).

Leading lecturer of the courses: *Object-Oriented Programming (Bachelors) (Ukrainian), Numerical Methods (Bachelors) (Ukrainian), Operations Research (Bachelors) (Ukrainian), Intelligent Control Systems (Bachelors), Distributed Computing Models and Software (PhD) (Ukrainian)*

GENERAL DESCRIPTION OF THE COURSE

Summary	The course “Numerical Methods” is a course in the cycle of professional compulsory training of the specialty 122 “Computer Science”. It is taught in the fourth semester in the amount of 120 hours (4 ECTS credits), in particular: lectures – 32 hours, laboratory classes – 32 hours, independent work – 56 hours. There are no individual tasks. The study of the discipline ends with the exam. The subject of the discipline is the technology and implementation of typical and modern numerical methods for calculating technical, physical and economic problems. The scientific basis for studying the discipline is the general mathematical training of students and the content of the disciplines "Higher Mathematics", "Algorithmization and Programming", as well as the existence of mathematical packages.
Course objectives	Introducing students to the main sections of computer mathematics, which are widely used in the design and development of mathematical and software. They consist in the study numerical methods, specification and implementation of classical methods of integration, differentiation, approximate calculation of functions, solving a system of algebraic equations.
Types of classes and control	Lectures, Laboratory work, control works, consultations. The course ends with a final exam
Term	4

Student workload (credits) / Type of course	4 / Mandatory	**Lectures (hours)**	32	**Workshops (hours)**	32	**Self-study (hours)**	56

Program competences	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. PC1. Ability to mathematically formulate and investigate 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. PC3. Ability to think logically, build logical conclusions, use formal languages and models of algorithmic calculations, design, development and analysis of algorithms, evaluate their efficiency and complexity, solvability and unsolvability of algorithmic problems for adequate modeling of subject areas and creation of software and information systems. PC4. Ability to use modern methods of objects mathematical modeling, processes and 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.

Learning outcomes	Teaching and learning methods	Forms of assessment (continuous assessment CAS, final assessment FAS)
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, teamwork, case method, method of feedback from students, problem-based learning	Written individual assignments for laboratory work (CAS), assessment of knowledge in laboratory classes (CAS), express survey (CAS), final / semester control in the form of a semester exam, according to the schedule of the educational process (FAS)
PLO5.Design, develop and analyze algorithms for solving computational and logical problems, evaluate the efficiency and complexity of algorithms based on the use of formal models of algorithms and computational functions	Interactive lectures with presentations, discussions, practical classes, teamwork, case method, method of feedback from students, problem-based learning	Written individual assignments for laboratory work (CAS), assessment of knowledge in laboratory classes (CAS), collection of data on individual assignments and reporting on research results (CAS), final / semester control in the form of a semester exam, according to the learning process schedule (FAS)
PLO6. 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	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), collection of data on individual assignments and reporting on research results (CAS), final / semester control in the form of a semester exam, according to the learning process schedule (FAS)

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
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** in the form of exam (30%) and current assessment (70%).
30% **exam**: semester exam, according to the schedule of the educational process
70% **continuous assessment**:
- 40% assessment of tasks in laboratory work;
- 30% intermediate control (3 control works)

Course policy	Follow the rules of the University internal regulations. Take an active part in the learning process. 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

Lecture 1	The subject of numerical methods. The concept and definition of the numerical methods theory. Methods Classification.	**Laboratory work 1**	Basics of work in mathematical packages. Two-dimensional and three-dimensional graphics in these packages.	**Self-Study**	Fundamentals of programming in selected mathematical packages.
Lecture 2	Approximate calculation of tabular functions. Basic theoretical positions. Lagrange interpolation polynomial. Newton's interpolation polynomial.	**Laboratory work 2**	Approximate calculation of functions		The concept of systematic and random computational errors. Error calculating of the function.
Lecture 3	Finding the values of the function zeros. Basic theoretical positions. The method of half division. Chord method. Newton's method.	**Laboratory work 3-4**	Finding the values of the function zeros.		Methods of approximation and extrapolation of tabular functions.
Lecture 4	Numerical methods of linear algebra. Numerical methods for solving a system of algebraic equations.	**Laboratory work 5-6**	Solving a system of algebraic equations		Iteration method.
Lecture 5	Linear algebra. Cramer's method. Gaussian method.				Consecutive approximation method. Seidel's method.
Lecture 6	Numerical differentiation of a table-given function.	**Laboratory work 7-8**	Numerical differentiation of a table-given function.		
Lecture 7	Differentiation of a				

	tabular given function by interpolation and approximation.				
Lecture 8	Numerical integration. The method of rectangles.	**Laboratory work 9-10**	Numerical integration.		Integration methods that are part of mathematical packages
Lecture 9	Numerical integration. Trapezoid method. Parabolic method.				Jacobi matrix. Chebyshev's quadrature formula.
Lecture 10	Solving ordinary differential equations. Euler's method.	**Laboratory work 11-12**	Solving systems of ordinary differential equations.		Gaussian quadrature formula
Lecture 11	Runge-Kutta methods.				Matrix methods of integration.
Lecture 12	Solving systems of ordinary differential equations	**Laboratory work 13-14**	Solving systems of ordinary differential equations.		Numerical methods for solving the Cauchy problem for systems of ordinary first-order differential equations.
Lecture 13	Parabolic differential equations in partial derivatives.				Numerical methods for solving the Cauchy problem for systems of ordinary second-order differential equations.
Lecture 14	Numerical methods for solving the Cauchy problem for ordinary differential equations.				Numerical methods for solving boundary value problems of second-order differential equations
Lecture 15	Solving differential equations in partial derivatives.	**Laboratory work 15**	Numerical determination of the derivative function		
Lecture 16	Mathematical data processing. Scheme of the least squares method.	**Laboratory work 16**	Mathematical data processing.		

RECOMMENDED READING

Compulsory	1. Volunteer L.O Zelinskaya O.V., Potapova N.A., Chikov I.A. (2020)Numerical methods: Textbook. Vinnytsia National Agrarian University. Vinnytsia: VNAU, 2. Domnin I.F., Verzhanovskaya M.R. (2008) Computational mathematics. Training manual. Kharki. 3. Mazmanishvili O.S., Shvarko Y.V.(1994) Workshop on numerical methods Kiev: SHSDO. 4. Zadachyn V.M, Konyushenko I.G. (2014) Numerical methods: textbook - Kharkov .: Ed. KhNEU S. Kuznets. 5. Andrunyk V.A., Vysotska V.A., Pasichnyk V.V., Chirun L.B., Chirun L.V. (2020) Numerical methods in computer science: textbook Lviv: Publishing House "New World - 2000". 6. Tretinik, V.V., Lyubashenko N.D. (2019) Methods of calculation: Part 1. Numerical methods of algebra textbook. way. for students. specialty 113 "Applied Mathematics", specialization "Data Science and Mathematical Modeling" Kyiv: KPI named Igor Sikorsky.	**Recommended**	1. Domnin I.F., Severin V.P., Nikulina E.N.(2014) Numerical methods of analysis and synthesis in radio electronics: textbook. Kharkov NTU «KhPI» 2. Knowledge Portal. Global intellectual resource. Retryeved from: http://statistica.ru/branches-maths/chislennye-metody-resheniya-uravneniy. 3. National open University http://www.intuit.ru/studies/courses. 4. Wikiversity.Retryeved from: https://ru.wikiversity.org/wiki. 5. Kontromat. Solving math problems. Retryeved from: http://kontromat.ru/. 6. http://math.semestr.ru/optim/optim-examples.php. 7. Lazarev Y.F. (2013) Handbook of MATLAB / Electronic textbook for course and diploma design. Kiev: NTUU "KPI".

ACADEMIC INTEGRITY

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.