NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE

Department of Descriptive Geometry, Computer Graphics and Design

APPROVED
Faculty of Engineering and Design
June 16, 2025

WORK PROGRAM
DISCIPLINE

MATHEMATICAL MODELING AND COMPUTER TECHNOLOGY

Field of Knowledge: G "Engineering, Production and Construction"
Specialty: G 19 "Construction and Civil Engineering"
Educational and professional program: "Construction and Civil Engineering"
Faculty of Engineering and Design
Developer: Professor of the Department of Descriptive Geometry,
Computer Graphics and Design
Doctor of Technical Sciences, Professor Viktor NESVIDOMIN

Kyiv – 2025

1. Description of the discipline "Mathematical Modeling and Computer Technologies"

Mathematical modeling and computer technologies is a scientific discipline that studies the principles of construction and functioning of computers, the organization of computing processes on personal computers, their algorithmization, PC software, as well as the effective use of modern information and communication technologies in construction activities. The main focus is on gaining skills in working with CAD technologies in computer graphics and CAS technologies in computer mathematics.

Field of knowledge, field of training, specialty, educational and qualification level		
Educational degree	Bachelor	
Speciality	G19 “Construction and Civil Engineering”	
Educational program	educational and professional	
Characteristics of the academic discipline		
View	Mandatory	
Total Hours	210	
Number of ECTS credits	7	
Number of content modules	4	
Course project (work)	-	
Form of control	Test / Exam	
Indicators of the academic discipline for full-time and part-time forms of study		
	Full-time form	part-time form
Year of preparation (course)	1	1
Semester	1, 2	1, 2
Lectures, hours.	30 / 30	2
Practical classes, hours.	30 / 0	4
Independent work, hours.	120	192
Individual tasks		
Number of Weekly Hours	4 / 2	

2. Purpose, objectives, competencies and program results of the discipline

The purpose of the discipline is to provide students with theoretical knowledge of the basics of computer technologies, to acquire practical skills in working on personal computers using existing CAS and CAD technologies on PCs in solving engineering problems in construction.

Task:

- to teach students the skills of developing graphic documentation using modern CAD environments;
- develop software packages in CAS environments for engineering calculations.

As a result of studying the discipline, a specialist should be able to:

- decompose the problem and implement program codes for their recording on the PC, implement numerical methods;
- to use the capabilities of computer graphics systems in the formation of 2D and 3D models of building structures.

Acquisition of competencies:

- Integral competence (IC):

IR – Ability to solve complex specialized problems of construction and civil engineering in the process of training, which involves the use of a set of theories and methods for determining strength, stability, deformability, modeling, strengthening of building structures; further safe operation, reconstruction, erection and installation of buildings and engineering structures; application of computer-aided design systems in the field of construction.

- General competencies (GC):

ZK01 – Ability to abstract thinking, analysis and synthesis.
ZK02 – Knowledge and understanding of the subject area and professional activities.
ZK04 – Ability to communicate in a foreign language.
ZK05 – Ability to use information and communication technologies.
ZK06 – Ability to search, process and analyze information from various sources.
ZK07 – Interpersonal Skills.

- Professional (special) competencies (FC):

SK04 – Ability to select and use appropriate equipment, materials, tools and methods for the design and implementation of technological processes of construction production.
SK05 – Ability to apply computerized design systems and specialized application software to solve engineering problems of construction and civil engineering.
SK06 – Ability to engineering activities in the field of construction, preparation and use of technical documentation.
SK07 – Ability to be responsible for making and making decisions in the field of architecture and construction in unpredictable work contexts.
SK11 – To master the methods of design, modeling and construction using systems of computer-aided design and calculation of building structures of buildings and engineering structures of industrial, agro-industrial, transport and civil facilities.

Program Learning Outcomes (PW):

PRN01 – Apply the basic theories, methods and principles of mathematical, natural, social and humanitarian and economic sciences, modern models, methods and software tools for decision support to solve complex problems of construction and civil engineering.
PRN03 – Present the results of their own work and argue their position on professional issues, to specialists and non-specialists, fluent in the state and foreign languages.
PRN06 – Apply modern information technologies to solve engineering and management problems of construction and civil engineering.
PRN07 – To collect, interpret and apply data, including by searching, processing and analyzing information from various sources.

3. Program and structure of the discipline

- full-time (part-time) form of study;
- shortened term of full-time (part-time) form of study.

Names of content	Number of hours

modules and themes	Full-time form						Correspondence form					
	Just	including					Just	including				
		l.	Pr	Lab	Indus	S.R.		l.	Pr	Lab	Indus	S.R.
1	2	3	4	5	6	7	8	9	10	11	12	13
1st semester												
Content module 1. Computer Mathematics System. Maple Soft												
Topic 1. Information. Computing systems. Units of information. Hardware.	6	2	2			4		2	2	2		2
Topic 2. Software. Windows MS Office. Information networks.	6	2	2			4		2	2	2		2
Topic 3. Mathematical modeling. Computer Mathematics Systems.	6	2	2			4		2	2	2		2
Topic 4. Programming elements in Maple. Types of data. Operands and operations.	6	2	2			4						
Topic 5. Operators. Operators condition and cycle. Sequences.	6	2	2			4		2	2	2		2
Topic 6. Functions. Procedures Expansion Packages. 2D graphics	6	2	2			4						
Topic 7. 3D graphics. Animation.	9	2	2			4						
Total for content module 1	45	14	14			28		8	8	8		8
Content module 2. Programming of engineering task in construction												
Topic 8. Vector operations in Maple.	6	2	2			4						
Topic 9. Matrix operations in Maple. Systems of linear equations.	6	2	2			4		2	2	2		2
Topic 10. Interpolation. Parabolic interpolation. Spline interpolation.	6	2	2			4		2	2	2		2
Topic 11. Approximation. Linear and quadratic approximations. Spline approximation.	6	2	2			4						
Topic 12. Nonlinear equations with one variable.	6	2	2			4						
Topic 13. Differentiation and integration. Approximate methods of integration.	6	2	2			4						
Topic 14. Optimization.	6	2	2			4						
Topic 15. Semester control	6	2	2			2						
Total for content module 2	45	16	16			4		4	4	4		4
2nd semester												
Content module 1. Fundamentals of Algorithmizing and Programming												

Topic 1. Hardware	6	2	2			4		2	2			2
Topic 2. Software	6	2	2			4		2	2			2
Topic 3. Fundamentals of algorithmizing	6	2	2			4		2	2			2
Topic 4. Programming elements	6	2	2			4						
Topic 5. Operators	6	2	2			4		2	2			2
Topic 6. Functions and procedures	6	2	2			4						
Topic 7. Graphics programming	6	2	2			4						
Total for content module 1	42	14	14			28		8	8			8
Content module 2. Engineering calculations in the MapleSoft environment												
Topic 8. Vectors in Maple	6	2	2			4						
Topic 9. Matrices in Maple	6	2	2			4		2	2			2
Topic 10. Interpolation	6	2	2			4		2	2			2
Topic 11. Approximation	6	2	2			4						
Topic 12. Solutions of equations	6	2	2			4						
Topic 13. Diff. and integration	6	2	2			4						
Topic 14. Optimization	6	2	2			4						
Topic 13. Credit work	6	2	2			4						
Total for content module 2	48	16	16			32		4	4			4
Total hours	90	30	30			60		12	12			12

4. Lecture topics (1st semester)

№	Name	H.
	1st semester	
1.	Information. Computing systems. Units of information. Hardware.	2
2.	Software. Windows MS Office. Information networks.	2
3.	Mathematical modeling. Computer Mathematics Systems.	2
4.	Programming elements in Maple. Types of data. Operands and operations.	2
5.	Operators. Operators condition and cycle. Sequences.	2
6.	Functions. Procedures Expansion Packages. 2D graphics	2
7.	3D graphics. Animation.	2
8.	Vector operations in Maple.	2
9.	Matrix operations in Maple. Systems of linear equations.	2
10.	Interpolation. Parabolic interpolation. Spline interpolation.	2
11.	Approximation. Linear and quadratic approximations. Spline approximation.	2
12.	Nonlinear equations with one variable.	2
13.	Differentiation and integration. Approximate methods of integration.	2
14.	Optimization.	2
15.	Preparation for the semester control	2
Total hours		30

5. Topics of practical classes

№	Name	H.
1st semester		
1.	Hardware.	2
2.	Maple Soft. Ms Visio.	2
3.	Linear algorithms.	2
4.	Branched algorithms.	2
5.	Cyclic algorithms	2
6.	Charts, flat curves lines.	2
7.	Surfaces. 3D animation.	2
8.	Vector operations.	2
9.	Matrix operations. Roots of linear equations.	2
10.	Linear and parabolic interpolation.	2
11.	Approximation. Processing data in Excel.	2
12.	Nonlinear equations with one variable.	2
13.	Differentiation and integration.	2
14.	Optimization.	2
15.	Semester control.	2
Total hours		30
2nd semester		
16.	Information Technology	2
17.	Hard & Soft Ware. CAS environments	2
18.	Maple Soft, Mathcad, Mathematica interface	2
19.	Programming Arithmetic Calculations	2
20.	Programming linear algorithms in the Maple environment	2
21.	Programming branched and cyclic algorithms	2
22.	Construction of curved lines and surfaces. Animation	2
23.	Vector operations	2
24.	Matrix operations. Systems of linear equations	2
25.	Data processing. Interpolation	2
26.	Approximation. Extrapolation.	2
27.	Nonlinear equations with one variable	2
28.	Differentiation and integration. Approximate methods	2
29.	Optimization methods	2
30.	Credit work	2
Total hours		30

6. Topics of independent work

№	Name	H.
1st semester		
1.	Hardware and software.	10

2.	Programming of linear, branched and cyclic algorithms.	10
3.	Curves and Surfaces.	10
4.	Vectors and matrices. Systems of linear equations.	10
5.	Interpolation and approximation. Data Processing.	10
6.	Functions. Roots. Integral. Optimization.	10
Total hours		60
2nd semester		
1.	Linear, branched, and cyclic algorithms	15
2.	Curved lines and surfaces. Animation	15
3.	Systems of linear equations. Interpolation and approximation	15
4.	Approximate methods for solving equations, diff. and integration, optimization	15
Total hours		60
Total hours		120

7. Tools for diagnosing learning outcomes

- Passed;
- Exam;
- unit tests;
- calculation and calculation and graphic works;
- defense of practical work;
- protection of independent work.

8. Teaching methods

- lectures and discussions;
- practical classes;
- visual methods (illustrations, demonstrations);
- work with educational and methodological literature (annotation, review, execution of design documentation, calculations);
- distance learning;
- performing independent work.

9. Assessment of learning outcomes

The knowledge of the applicant for higher education is assessed on a 100-point scale, which is converted into a national assessment in accordance with the current "Regulations on Exams and Tests in the NUBiP of Ukraine"

9.1. Distribution of points by types of educational activities (1st semester)

Type of educational activity	Learning outcomes	Evaluation
Module 1. Computer Mathematics System. Maple Soft		
Practice 1. Hardware.	PRN 01, 03, 06, 07. Ability to write programs for linear, branched, and cyclic	**6**
Practice 2. Maple Soft. Ms Visio.		**9**
Practice 3. Linear algorithms.		**9**

Practice 4. Branched algorithms.	algorithms; plot graphs; construct curves and surfaces; and create 3D animations using MapleSoft and MS Visio software.	**9**
Practice 5. Cyclic algorithms.		**9**
Practice 6. Charts, flat curves lines.		**9**
Practice 7. Surfaces. 3D animation.		**9**
Independent work 1. Hardware and software.		**10**
Independent work 2. Programming of linear, branched and cyclic algorithms.		**10**
Independent work 3. Curves and Surfaces.		**10**
Modular test work 1	Checking the acquired skills in the discipline in the first module.	**10**
Total for module 1		**100**
Module 2. Programming of engineering task in construction		
Practice 8. Vector operations.	PRN 01, 03, 06, 07. Ability to perform vector and matrix operations, linear and parabolic interpolation, approximation, differentiation, integration, and data optimization using MapleSoft and MS Visio software. Ability to process data in Excel.	**9**
Practice 9. Matrix operations. Roots of linear equations.		**9**
Practice 10. Linear and parabolic interpolation.		**9**
Practice 11. Approximation. Processing data in Excel.		**9**
Practice 12. Nonlinear equations with one variable.		**9**
Practice 13. Differentiation and integration.		**9**
Practice 14. Optimization.		**9**
Independent work 4. Vectors and matrices. Systems of linear equations. Interpolation and approximation. Data Processing.		**10**
Independent work 5. Functions. Roots. Integral.		**10**
Independent work 6. Optimization.		**10**
Modular test work 2	Checking the acquired skills in the discipline in the second module.	**10**
Total by module 2		**100**
Educational work	**(M1 + M2)/2*0.7 ≤ 70**	
Passed	**30**	
Total for the course	**(Academic work + credit) ≤ 100**	

9.2. Distribution of points by types of educational activities (2nd semester)

Type of educational activity	Learning outcomes	Evaluation

Module 1. Engineering graphics in the Autodesk Inventor environment		
Practice. 1. Operating with units of measurement of information	PRN 01, 03, 06, 07. Understanding of the operation of a PC, its hardware and software. Be able to develop mathematical models of engineering problems. Know the algorithmizing of problem solving and their software implementation in CAS environments, in particular, in MapleSoft	**5**
Practice. 2. Installation of CAS. Maple interface		**5**
Practice. 3. Programming basic mathematical operations		**5**
Practice. 4. Programming linear algorithms		**5**
Practice. 5. Programming logical problems		**5**
Practice. 6. Programming cyclic algorithms		**5**
Practice. 7. Programming the construction of curved lines and surfaces		**5**
Independent 1. Linear, branched, and cyclic algorithms		**15**
Independent 2. Curved lines and surfaces		**15**
Modular test work 1	Checking the acquired skills in the discipline in the first module.	**15**
Unit Test 1		**10**
Unit Test 2		**10**
Total for module 1		**100**

Module 2. Computer Mathematics		
Practice. 8. Vector Operations Programming	PRN 01, 03, 06, 07Ability to create software for solving engineering problems in vector and matrix forms. Understand the processing of discrete data, their representation by interpolations and approximation polynomials. Understanding Approximate	**5**
Practice. 9. Programming matrix operations		**5**
Practice. 10. Programming Parabolic and Spline Interpolation		**5**
Practice. 11. Programming approximation using the method of least squares		**5**
Practice. 12. Programming approximate methods for solving equations		**5**

Practice. 13. Programming of approximate methods of diff. and integration	Methods for Solving Mathematical Models	**5**
Practice. 14. Programming optimization methods		**5**
Independent 3. Systems of linear equations. Interpolation and approximation		**15**
Independent 4. Approximate methods for solving equations, diff. and integration, optimization		**15**
Modular test work 2	Checking the acquired skills in the discipline in the second module.	**15**
Unit Test 3		**10**
Unit Test 4		**10**
Total by module 2		**100**
Educational work	**(M1 + M2)/2*0.7 ≤ 70**	
Exam	**30**	
Total for the course	**(Academic work + credit) ≤ 100**	

9.2. Scale of assessment of higher education applicant's knowledge

Rating of the applicant for higher education, Points	Assessment according to the national system (exams/tests)
90-100	Perfectly
74-89	well
60-73	Satisfactory
0-59	Disappointing

9.3. Assessment Policy

Deadline and retake policy:	Works that are submitted in violation of deadlines without a valid reason are evaluated for a lower grade. Retaking modules takes place with the permission of the lecturer in the presence of valid reasons (for example, sick leave).
Academic Integrity Policy:	Cheating during tests and exams is prohibited (including using mobile devices). Term papers, abstracts must have correct text references to the literature used.
Attendance Policy:	Attendance at classes is mandatory. For objective reasons (for example, illness, international internship), training can take place individually (in online form in agreement with the dean of the faculty).

10. Educational and methodological support

Training is carried out by means of information and communication technologies in education. A certified electronic training course on the ELearn platform "Mathematical Modeling and Computer Technologies" is used.

https://elearn.nubip.edu.ua/course/view.php?id=2882
https://elearn.nubip.edu.ua/course/view.php?id=2464

Classes are held in the following sequence:

- presentation of new material (lecture, classroom lesson);
- consolidation of new material (independent work outside the classroom, using literature and electronic resources);
- consolidation of acquired skills and abilities (classroom lesson);
- improvement of skills acquired in previous classes (work in extracurricular hours with the study of lecture material, use of literature, Internet resource).

11. Recommended sources of information

Based:

1. https://www.maplesoft.com
2. https://www.autodesk.com/
3. https://www.solidworks.com/
4. Computer Science and Computer Engineering / Tkach T. B. – Odesa, 2019. – 100 p. (in Russian).
5. Numerical Methods: Textbook / Volontyr L. O., Zelinska O. V., Potapova N. A., Chikov I. A. – Vinnytsia: VNAU, 2020. – 322 p.
6. Algorithms and methods of calculations [Electronic resource]: nauch. Manual. / M. A. Novotarsky. – Kyiv: KPI. Igor Sikorsky, 2019. – 407 p. (in Russian).
7. Numerical methods: teaching. manual / O. I. Yaroshenko, M. V. Hryhorkiv. – Chernivtsi: Chernivtsi Nats. University of Pennsylvania, 2018. – 172 p. (in Russian).
8. Information Technologies: Teaching. Manual / R. O. Tarasenko, S. M. Garina, T. P. Rabocha; Kyiv: LLC "Alef", 2011. – 332 p. (in Russian).
9. Gindis E. J., Kaebisch R. C. (2020). Up and Running with AutoCAD 2021: 2D and 3D Drawing, Design and Modeling. Netherlands: Elsevier Science.

Secondary:

10. Sytnyk V. F. Osnovy informatsionnykh sistem: Navch. Manual. – Ed. 2nd, reworked. And additional. / Ed. V. F. Sitnika. – K.: KNEU, 2001. – 420 p. (in Russian).
11. Information Systems and Technologies: Teaching. Manual. for students / O. V. Gritsunov; Khark. National. Acad. city. economy. – Kh.: KNAMG Publ., 2010. – 222 p. (in Russian).
12. Nelyubov V. O., Kurutsa O. S. Fundamentals of Informatics. Microsoft Excel 2016: Tutorial. Uzhhorod: State Higher Educational Institution "UzhNU", 2018. – 58 p. (in Russian).

13. Computer Graphics: Textbook: Book 1. for students of specialty 151 "Automation and computer-integrated technologies" / Compilers: Totosko O. V., Mykytyshyn A. G., Stukhlyak P. D. – Ternopil: Ternopil National Technical University named after Ivan Pulyuy, 2017. – 304 p.
14. Lyashenko B. M., Kryvonos O. M., Vakalyuk T. A. Methods of Calculations: Educational and Methodological Manual for Students of the Faculty of Physics and Mathematics. – Zhytomyr: ZhDU Publ., 2014. – 228 c.

Recommended regulatory documents:

15. Standard of Higher Education in the specialty 122 "Computer Science" for the first (bachelor's) level of higher education. URL: https://mon.gov.ua/storage/app/media/vishcha-osvita/zatverdzeni%20standarty/2019/07/12/122-kompyut. nauk.bakalavr-1.pdf.
16. New Information Technologies, Electronic Manual. Access Mode http://www.eduforme.org/mod/page/view.php?id=13.
17. Gnidenko I. G., Sokolovska S. A. Informatics. Google Books Site / 10.06.2007. http://www.books.google.com.ua/books?isbn=5765429521