National Technical University of Ukraine «IGOR SIKORSKY KYIV POLYTECHNIC INSTITUTE»

Department emblem (if available)

Department of Mathematical Physics and Differential Equations

Higher Mathematics 2. Differential Calculus.
Working Program of the Academic Discipline (Syllabus)

Course Details	
Level of higher education	**First (Bachelor's)**
Branch of knowledge	G Engineering, Manufacturing and Construction
Specialty	G7 Automation, Computer-Integrated Technologies and Robotics
Educational program	Computer-Integrated Technologies and Robotics
Course status	Mandatory
Form of study	Full-time (day)
Year of study, semester	1st year, spring semester (2)
Course workload	**180 hours / 6 ECTS credits** Lectures: **30** | Practical classes (seminars): **44** | Laboratory classes (computer practicum): **0** | Individual classes: **0** | Self-study: **106**
Semester control / control measures	Exam: **+** | Credit: **-** | MCW (specify number): **1** | CGW, CW, GW (specify number): **1** | HCW (specify number): **0** | Essay (specify number): **0**
Class schedule	On the university website: rozklad.kpi.ua
Language of instruction	Ukrainian
Information about the course leader / teachers	Lecturer: PhD (Physics and Mathematics), Associate Professor Olha Sulima olgasulimakpi@gmail.com Practical classes: PhD (Physics and Mathematics), Associate Professor Olha Sulima, https://intellect.kpi.ua/profile/sov203
Course placement	https://ecampus.kpi.ua Department website, library information resources

Course Program

1. Course description, its aim, subject of study and learning outcomes

The aim of the course "Higher Mathematics 2. Differential Calculus" is to develop students' integral competence: the ability for logical thinking, analysis and synthesis, the formation of students' personality, the development of their intellect and abilities, the ability to solve complex specialized problems and practical issues of professional activity in the latest technologies, and to use methods of mathematical analysis in engineering calculations.

The course aims to provide students with the knowledge, skills and abilities needed to master professionally oriented disciplines and to give the necessary basic mathematical training for solving specialized problems of instrument engineering, for the development, improvement and operation of existing automation systems using modern hardware, software and information technologies, and for theoretical research of automation objects.
Teaching mathematics involves:
– development of logical and algorithmic thinking;
– mastering the main methods of investigating and solving mathematical problems;
– mastering the main numerical methods of mathematics;
– the ability to apply mathematical knowledge independently and to carry out mathematical analysis of applied engineering problems.
The objective of studying the course is to develop competences (GC – general, PC – professional (special, subject-specific)):

General Competences (GC)
***GC 1**. Ability to learn and master modern knowledge.*
***GC 2.** Knowledge and understanding of the subject area and understanding of professional activity.*
***GC 3**. Ability to apply knowledge in practical situations.*
***GC 4**. Ability to make informed decisions.*
***GC 5**. Ability to search for, process and analyse information from various sources.*
***GC 7.** Ability to work autonomously and in a team.*
***GC 8.** Ability to communicate in the state language both orally and in writing.*
***GC 9.** Ability to communicate in a foreign language.*
***GC 10.** Skills in using information and communication technologies.*

Professional Competences (PC)
***PC 1.** Ability to apply knowledge of mathematics to the extent necessary to use mathematical methods for the analysis and synthesis of automation systems.*
***PC 2**. Ability to apply methods of systems analysis, mathematical modelling and numerical methods to develop mathematical models of individual elements and of automation systems as a whole, and to analyse the quality of their operation using the latest computer technologies.*

Programme Learning Outcomes (PLO)
***PLO 1.** To know linear and vector algebra, differential and integral calculus of functions of one and several variables, power and functional series, and differential equations to the extent necessary to use mathematical tools and mathematical methods in the field of automation.*
***PLO 2**. To be able to apply methods of systems analysis, modelling, identification and numerical methods to develop mathematical and simulation models of individual elements and of automation systems as a whole, and to analyse the quality of their operation using the latest computer technologies.*
***PLO 3.** To be able to use a variety of specialized software to solve typical engineering problems in the field of automation, in particular mathematical modelling, computer-aided design, database management and computer graphics methods.*

2. Prerequisites and postrequisites of the course (place in the structural and logical scheme of training under the relevant educational program)

The course is taught in the 2nd semester on the basis of complete general secondary or vocational secondary education.

3. Course content

Topic 1. Integral calculus of a function of one variable.
Topic 2. Functions of several variables.
Topic 3. Ordinary differential equations and systems of differential equations.

4. Educational materials and resources

Main literature

1. Dubovyk V. P. Higher Mathematics / V. P. Dubovyk, I. I. Yuryk. – Kyiv: Vyshcha shkola, 2013. – 648 p. [in Ukrainian]
2. Shkil M. I. Mathematical Analysis. Part 2 / M. I. Shkil. – Kyiv, 1981. – 456 p. [in Ukrainian]
3. Hrymaliuk V. P. Higher Mathematics: in 2 parts: textbook / V. P. Hrymaliuk, M. M. Kukharchuk, V. V. Yasinskyi. – Kyiv: Vipol, 2004. – Part 1. – 376 p. [in Ukrainian]
4. Dubovyk V. P. Higher Mathematics. Collection of Problems: textbook / V. P. Dubovyk, I. I. Yuryk. – Kyiv: A.S.K., 2005. – 648 p. [in Ukrainian]
5. Problems in Higher Mathematics for Calculation Works and MCW for 1st-Year Students of Technical Specialties / O. V. Kuzma, T. O. Rudyk, O. V. Sulima [et al.]; Ministry of Education and Science of Ukraine, NTUU "KPI". – Kyiv: NTUU "KPI", Omeha, 2007. – 56 p. [in Ukrainian]

Additional literature

1. Ivasyshen S. D. Differential Equations: Methods and Applications: textbook / S. D. Ivasyshen, V. P. Lavrenchuk, P. P. Nastasiiev, I. I. Drin. – Chernivtsi: Chernivtsi National University, 2010. – 288 p. [in Ukrainian]
2. Stryzhak T. H. Mathematical Analysis: Examples and Problems: textbook / T. H. Stryzhak, N. R. Konovalova. – Kyiv: Lybid, 1995. – 240 p. [in Ukrainian]
3. Guidelines for Organizing Independent Work on the Topic "Improper Integrals. Gamma and Beta Functions" / compiled by T. N. Bartnovska, O. V. Kuzma, V. I. Stohnii, O. V. Sulima. – Kyiv: KPI, 1992. – 40 p. (available in electronic form in the Electronic Campus system of NTUU "KPI"). [in Ukrainian]
4. Herasymchuk V. S. Higher Mathematics. A Complete Course in Examples and Problems: in 3 parts: textbook / V. S. Herasymchuk, H. S. Vasylchenko, V. I. Kravtsov. – Kyiv: Knyhy Ukrainy LTD, 2009. – Part 1. – 578 p.; 2010. – Part 2. – 470 p.; 2009. – Part 3. – 400 p. [in Ukrainian]

Educational Content

5. Methods of mastering the course (educational component)

The main forms of learning are lectures, practical classes, individual assignments and students' independent work.

In lectures, students are taught the theoretical foundations of the course.

List of lectures

Lecture 1. Antiderivative. Indefinite integral

1.1. The concept of an antiderivative. Properties of an antiderivative.
1.2. Indefinite integral. Main properties.
1.3. Table of basic indefinite integrals.
1.4. Change of variable, bringing the derivative under the differential sign.

Lecture 2. Basic methods of integration

2.1. Integration by parts. Main classes of functions integrated by parts.
2.2. Rational functions. Proper and improper rational functions, extracting the integer part.
2.3. Partial fractions and their integration.
2.4. Decomposition of a proper fraction into a sum of partial fractions.
2.5. Integration of rational functions.

Lecture 3. Integration of functions rationally dependent on trigonometric functions

3.1. Special cases.
3.2. Universal trigonometric substitution.
3.3. Integration of products of sines and cosines.

Lecture 4. Integration of some irrational functions. Chebyshev's theorem

4.1. Integration of some classes of irrational functions containing a linear or linear-fractional function under the root sign.
4.2. Integration of irrational functions containing a quadratic function under the root sign.
4.3. Euler substitutions.
4.4. Integration of differential binomials. Chebyshev's theorem.

Lecture 5. Definite integral

5.1. The concept and geometric meaning of an integral sum.
5.2. Definition of the definite integral. Necessary condition for the integrability of a function.
5.3. Upper and lower Darboux sums and their properties.
5.4. Criterion for the integrability of a function on a closed interval.
5.5. Classes of integrable functions.

Lecture 6. Properties of the definite integral and of integrable functions.
The Newton–Leibniz theorem

6.1. Properties of the definite integral.
6.2. Mean value theorems.
6.3. The definite integral as a function of the upper limit of integration.
6.4. The Newton–Leibniz formula.
6.5. Basic methods of integration of definite integrals.

Lecture 7. Improper integrals of the 1st and 2nd kinds

7.1. The concept of an improper integral of the 1st kind.
7.2. Tests for convergence and divergence of improper integrals of the 1st kind.
7.3. The concept of an improper integral of the 2nd kind.
7.4. Tests for convergence and divergence of improper integrals of the 2nd kind.
7.5. Transformation and calculation of improper integrals.

Lecture 8. Geometric applications of definite integrals

8.1. Area of a plane figure.
8.2. Area of a curvilinear sector.
8.3. Volumes of solids of revolution and volumes by the cross-section formula.
8.4. Area of a surface of revolution.
8.5. Arc length of a curve. Calculation for different ways of defining a curve.
Mechanical applications of definite integrals
Approximate methods for calculating definite integrals.
8.6. Static moments and coordinates of the centre of mass of an arc. Pappus–Guldinus first theorem.
8.7. Static moments and coordinates of the centre of mass of a plane figure. Pappus–Guldinus second theorem.

Lecture 9. Functions of several variables (FSV)

9.1. The concept of the Euclidean space R^m.
9.2. The concept of an FSV. Geometric meaning of a function of two variables.
9.3. Continuity of an FSV. Weierstrass's first and second theorems.

9.4. Partial derivatives, total differential of an FSV.
9.5. Application of the differential to approximate calculations.

Lecture 10. Differentiation of functions of several variables

10.1. Differentiation of a composite function. Invariance of the form of the first differential.
10.2. Derivative of an implicitly defined function.
10.3. Higher-order partial derivatives and differentials.
10.4. Extrema of an FSV. Sufficient conditions for an extremum.

Lecture 11. Ordinary differential equations

11.1. Basic concepts, general and particular solutions. Statement of the Cauchy problem.
11.2. Problems leading to differential equations.
11.3. First-order differential equations solved for the derivative.
11.4. Geometric interpretation of the Cauchy problem. Integral curve.

Lecture 12. First-order ordinary differential equations

12.1. Separable differential equations.
12.2. Homogeneous differential equations. Differential equations reducible to homogeneous ones.
12.3. First-order linear differential equations: homogeneous and non-homogeneous. Lagrange's method.
12.4. Properties of the solution of a linear differential equation.
12.5. Bernoulli equation.

Lecture 13. First-order ordinary differential equations. Picard's theorem

13.1. Exact differential equations.
13.2. Integrating factor and its existence.
13.3. The Cauchy problem. Picard's theorem on the existence and uniqueness of the solution of the Cauchy problem.
13.4. Peano's theorem on the existence of the solution of the Cauchy problem.

Lecture 14. Higher-order differential equations

14.1. Basic concepts. General and particular solutions.
14.2. The Cauchy problem. Picard's theorem.
14.3. Higher-order differential equations that allow reduction of order.
14.4. Linear differential equations of order n: homogeneous (HLDE) and non-homogeneous (NLDE).
14.5. Linear independence of solutions. The Wronskian. The Ostrogradsky–Liouville–Jacobi formula.

Lecture 15. Linear differential equations with constant coefficients

15.1. HLDE with constant coefficients. Construction of a fundamental system of solutions.
15.2. NLDE with constant coefficients and a right-hand side of special form.
15.3. Method of undetermined coefficients. All special cases.
Linear non-homogeneous differential equations (NLDE) of order n.
Systems of differential equations
15.4. Theorems on the general solutions of HLDE and NLDE.
15.5. Method of variation of arbitrary constants (Lagrange's method).
15.6. Reduction of a system of linear differential equations to one differential equation of order n.

In practical classes – assignments (according to the list of main literature given above)

List of practical classes (indicative)

Practical class 1. Calculation of indefinite integrals. Bringing the derivative under the differential sign. Change of variable. Integration of some functions containing a quadratic trinomial.

Practical class 2. Integration by parts.

Practical class 3. Integration of rational functions (real multiple roots of the denominator).

Integration of rational functions (complex conjugate multiple roots of the denominator).

Practical class 4. Integration of trigonometric functions. Various cases.

Practical class 5. Integration of some classes of irrational functions. Chebyshev's theorem.

Practical class 6. Calculation of integrals using trigonometric substitutions. Euler substitutions.

Practical class 7. Calculation of definite integrals by various methods.

Practical class 8. Calculation and investigation of convergence of improper integrals of the 1st kind.

Practical class 9. Calculation and investigation of convergence of improper integrals of the 2nd kind.

Practical class 10. Calculation of the area of a plane figure and the arc length of a curve. Calculation of the volume and surface area of a solid.

Practical class 11. Mechanical applications of definite integrals. Finding the mass, static moments and coordinates of the centre of mass of an arc and a plane figure.

Practical class 12. Test "Integrals and Their Applications to Problems of Geometry and Mechanics".

Practical class 13. Review of the test. Finding partial derivatives of an FSV, the total differential, the derivative of a composite FSV and the derivative of an implicitly defined function.

Practical class 14. Calculation of higher-order partial derivatives and differentials of an FSV. Finding extrema of a function of two variables.

Practical class 15. Solving separable and homogeneous first-order differential equations.

Practical class 16. Solving first-order linear differential equations by Lagrange's method. The Cauchy problem. Solving Bernoulli equations.

Practical class 17. Solving exact differential equations. Integrating factor.

Practical class 18. Solving higher-order differential equations that allow reduction of order.

Practical class 19. Solving HLDE, constructing the characteristic equation.

Practical class 20. Solving higher-order NLDE with constant coefficients and a right-hand side of special form.

Practical class 21. Solving second-order NLDE with constant coefficients. Lagrange's method. Test "Differential Equations".

Practical class 22. Review of the test. Final practical class of the second semester.

6. Student's independent work

Students' independent work includes consolidating and deepening knowledge from the lecture materials, independent study of selected topics using the recommended teaching materials, preparation for practical classes, completion of a home control work, and completion of the calculation and graphic work (divided into two parts according to the scheduled semester attestations).

Policy and Control

7. Course policy (educational component)

The following requirements apply to students:

- ***attendance rules:***
  - *do not be late for classes; if more than 15 minutes late, enter in the second half of the class so as not to distract others; notify the teacher in advance about missing a class for a valid reason or due to illness (confirm with a copy of a medical certificate);*
  - *in distance learning mode: Zoom conference via the teacher's link;*
- ***rules of conduct in class:***
  - *engaging in any activity not directly related to the course or to maintaining health is prohibited;*
  - *the use of communication devices to search the Internet or the Moodle distance learning platform for information needed to complete assignments is allowed;*
  - *disrupting classes in any way is prohibited;*

- ***rules for awarding bonus and penalty points:***
  - *penalty points are given for late completion and defence of the CGW; bonus points are given for activity in practical classes;*
  - *the maximum number of bonus and penalty points is determined in accordance with the Regulations on the System for Assessing Learning Outcomes at Igor Sikorsky Kyiv Polytechnic Institute, the Regulations on Current, Calendar and Semester Control of Learning Outcomes at Igor Sikorsky Kyiv Polytechnic Institute, and other regulations and recommendations in force at Igor Sikorsky Kyiv Polytechnic Institute;*
- ***assessment policy for control measures:***
  - *control measures are assessed in accordance with the Regulations on the System for Assessing Learning Outcomes at Igor Sikorsky Kyiv Polytechnic Institute, the Regulations on Current, Calendar and Semester Control of Learning Outcomes at Igor Sikorsky Kyiv Polytechnic Institute, and other regulations and recommendations in force at Igor Sikorsky Kyiv Polytechnic Institute;*
  - *the lower limit of a positive assessment for each control measure must be at least 60% of the points allocated to that control measure;*
  - *a negative result is assessed as 0 points.*

Academic Integrity

The policy and principles of academic integrity are defined in Section 3 of the Code of Honour of Igor Sikorsky Kyiv Polytechnic Institute. More details: https://kpi.ua/code.

Norms of Ethical Behaviour

The norms of ethical behaviour of students and staff are defined in Section 2 of the Code of Honour of Igor Sikorsky Kyiv Polytechnic Institute. More details: https://kpi.ua/code.

Appeals against Control Measure Results

Students have the right to raise any issue related to the procedure for conducting or assessing control measures and to expect it to be considered by a commission.

8. Types of control and the rating system for assessing learning outcomes (RSA)

Current control (maximum score – 50 points):
– writing thematic control works (TCW 1, TCW 2);
– writing the modular control work (MCW parts 1, 2);
– writing and defending the calculation and graphic work (CGW parts 1, 2);

Table of correspondence between rating points and types of current control.

Type of current control	*Maximum possible number of points*
TCW 1, TCW 2	10 points (5+5)
MCW (parts 1, 2)	20 points (10+10)
CGW (parts 1, 2)	20 points (10+10)

Scoring criteria:

1. Completion of the thematic control work.

Thematic control works (TCW 1, TCW 2) are conducted on the topics of the sections "Indefinite Integrals. Basic Methods of Integration" and "Functions of Several Variables".

"excellent" – 5 points – The tasks are completed correctly and contain all the necessary calculations and explanations.

"good" – 4–4.5 points – The tasks are completed correctly, but there are shortcomings. In particular, correct approaches to the solution are used, but explanations are completely missing, there are calculation errors, etc. However, these shortcomings indicate insufficient attention while completing the task rather than a lack of knowledge and skills.

"satisfactory" – 3–3.5 points – The tasks are completed partially or with some errors. In particular, a formula is written incorrectly, which leads to a wrong answer, or there are significant errors in transforming analytical expressions. However, the generally correct approach to solving the tasks is shown.

"unsatisfactory" – 0–2.5 points – The tasks are completed incorrectly or with significant errors (less than 60% of the meaningful steps are performed correctly).

2. Completion of the modular control work.

The modular control work (MCW) consists of two parts and covers the topics of the sections "Integrals and Their Applications to Problems of Geometry and Mechanics" and "Differential Equations". The modular control work contains a theoretical and a practical part.

"excellent" – 9.5–10 points – The answer to the theoretical questions is complete and correct and contains the necessary explanations, analytical expressions and graphs. The practical tasks are completed correctly and contain all the necessary calculations and explanations.

"good" – 7.5–9 points – The answer to the theoretical questions is sufficiently complete and correct and contains the necessary explanations, analytical expressions and graphs. However, the analytical expressions do not include explanations of their components, the graphs lack the necessary labels, and the answer is not illustrated with an example. The practical tasks are completed correctly and correct approaches to the solution are used, but explanations are completely missing, there are calculation errors, etc. Thus, the tasks are not complete enough, but at least 75% of the essential content is presented.

"satisfactory" – 6–7 points – The answer to the theoretical questions is correct but incomplete. Some necessary analytical expressions or graphs are missing. The answer contains a significant amount of information that corresponds to the general topic of the question but does not specify the aspects stated in the question itself. The practical tasks are completed partially or with some errors. In particular, a formula is written incorrectly, which leads to a wrong answer, or there are significant errors in transforming analytical expressions. However, the generally correct approach to solving the tasks is shown. The answer is at least 60% complete in terms of essential content.

"unsatisfactory" – 0–5 points – The answer to the theoretical questions contains less than 60% of correct and meaningful information. Key explanations and important analytical expressions are missing. The practical tasks are completed incorrectly or with significant errors (less than 60% of the meaningful steps are performed correctly).

3. Completion of the calculation and graphic work.

The calculation and graphic work (CGW) consists of two parts and covers the topics of the sections "Integrals and Their Applications to Problems of Geometry and Mechanics" and "Differential Equations". A defence of the calculation and graphic work is required. A student is admitted to the defence provided that all tasks are completed correctly, with possible minor shortcomings and errors.

"excellent" – 9.5–10 points – The tasks are completed correctly and contain all the necessary calculations and explanations.

"good" – 7.5–9 points – The tasks are completed correctly and correct approaches to the solution are used, but explanations are completely missing, there are calculation errors, etc. Thus, the tasks are not complete enough, but at least 75% of the essential content is presented.

"satisfactory" – 6–7 points – The tasks are completed partially or with some errors. In particular, a formula is written incorrectly, which leads to a wrong answer, or there are significant errors in transforming analytical expressions. However, the generally correct approach to solving the tasks is shown. The answer is at least 60% complete in terms of essential content.

"unsatisfactory" – 0–5 points – The tasks are completed incorrectly or with significant errors (less than 60% of the meaningful steps are performed correctly).

Calendar control is carried out twice a semester to monitor the current status of meeting the syllabus requirements.

Table of correspondence between attestation dates and the conditions for receiving attestation.

Attestation date	*Conditions for receiving attestation*	
	Current rating	*Current control measure*
Week 7	≥ 50% of the maximum possible number of points at that moment	TCW 1, TCW 2 MCW (part 1)
Week 13	≥ 50% of the maximum possible number of points at that moment	TCW 1, TCW 2 MCW (parts 1, 2) CGW (parts 1, 2)

Semester control: exam (maximum score – 50 points).

The exam paper consists of two theoretical questions and three practical tasks. The number of points a student can receive for answering a theoretical question or solving a practical task:

– a complete answer to a theoretical question or a correctly solved practical task – 10 points;

– minor errors in the answer to a theoretical question or in solving a practical task – 6 points;

– an incomplete answer to a theoretical question or errors in solving a practical task – 3 points;

– no answer to a theoretical question or the practical task is not completed – 0 points.

A student's rating for the credit module is determined on a 100-point scale and consists of the points received for all types of current control and the points received at the exam.

Conditions for admission to semester control: a minimum positive grade for the modular control work and the calculation and graphic work. The semester rating is at least 36 points.

***Current control**: express surveys, surveys on the topic of the class, writing control works, testing.*

***Calendar control**: carried out twice a semester to monitor the current status of meeting the syllabus requirements.*

***Semester control:** exam.*

Conditions for admission to semester control: credit for the calculation and graphic work, semester rating of at least 36 points.

Exam retakes take place within the period set by the dean's office.

Table of correspondence between rating points and grades on the university scale:

Number of points	Grade
100-95	Excellent
94-85	Very good
84-75	Good
74-65	Satisfactory
64-60	Sufficient
Less than 60	Unsatisfactory
Admission conditions not met	Not admitted

9. Additional information on the course (educational component)

List of questions for semester control:

1. The concept of an antiderivative. Properties of an antiderivative.
2. Indefinite integral. Main properties.
3. Table of basic indefinite integrals.
4. Change of variable, bringing the derivative under the differential sign.
5. Integration by parts. Main classes of functions integrated by parts.
6. Rational functions. Proper and improper rational functions, extracting the integer part.
7. Partial fractions and their integration.
8. Decomposition of a proper fraction into a sum of partial fractions.
9. Integration of rational functions.
10. Integration of functions rationally dependent on trigonometric functions. Special cases.
11. Universal trigonometric substitution. Integration of products of sines and cosines.
12. Integration of some classes of irrational functions containing a linear or linear-fractional function under the root sign.
13. Integration of irrational functions containing a quadratic function under the root sign.
14. Euler substitutions.
15. Integration of differential binomials. Chebyshev's theorem.
16. The concept and geometric meaning of an integral sum.
17. Definition of the definite integral. Necessary condition for the integrability of a function.
18. Upper and lower Darboux sums and their properties.
19. Criterion for the integrability of a function on a closed interval.
20. Classes of integrable functions.
21. Properties of the definite integral and of integrable functions.
22. Mean value theorems.
23. The definite integral as a function of the upper limit of integration.
24. The Newton–Leibniz formula.
25. Basic methods of integration of definite integrals.
26. The concept of an improper integral of the 1st kind.
27. Tests for convergence and divergence of improper integrals of the 1st kind.
28. The concept of an improper integral of the 2nd kind.
29. Tests for convergence and divergence of improper integrals of the 2nd kind.
30. Transformation and calculation of improper integrals.
31. Geometric applications of definite integrals. Area of a plane figure.

32. Area of a curvilinear sector.
33. Volumes of solids of revolution and volumes by the cross-section formula.
34. Area of a surface of revolution.
35. Arc length of a curve. Calculation for different ways of defining a curve.
36. Mechanical applications of definite integrals. Static moments and coordinates of the centre of mass of an arc. Pappus–Guldinus first theorem.
37. Static moments and coordinates of the centre of mass of a plane figure. Pappus–Guldinus second theorem.
38. Approximate methods for calculating definite integrals.
39. Functions of several variables (FSV). The concept of the Euclidean space R^m.
40. The concept of an FSV. Geometric meaning of a function of two variables.
41. Continuity of an FSV. Weierstrass's first and second theorems.
42. Partial derivatives, total differential of an FSV.
43. Application of the differential to approximate calculations for an FSV.
44. Differentiation of a composite FSV. Invariance of the form of the first differential of an FSV.
45. Derivative of an implicitly defined FSV.
46. Higher-order partial derivatives and differentials of an FSV.
47. Extrema of an FSV. Sufficient conditions for an extremum.
48. Ordinary differential equations. Basic concepts, general and particular solutions. Statement of the Cauchy problem.
49. Problems leading to differential equations.
50. First-order differential equations solved for the derivative.
51. Geometric interpretation of the Cauchy problem. Integral curve.
52. Separable differential equations.
53. Homogeneous differential equations. Differential equations reducible to homogeneous ones.
54. First-order linear differential equations: homogeneous and non-homogeneous. Lagrange's method.
55. Properties of the solution of a first-order linear differential equation.
56. Bernoulli equation.
57. Exact differential equations.
58. Integrating factor and its existence.
59. The Cauchy problem. Picard's theorem on the existence and uniqueness of the solution of the Cauchy problem.
60. Peano's theorem on the existence of the solution of the Cauchy problem.
61. Higher-order differential equations. Basic concepts. General and particular solutions.
62. Higher-order differential equations. The Cauchy problem. Picard's theorem.
63. Higher-order differential equations that allow reduction of order.
64. Linear differential equations of order n: homogeneous (HLDE) and non-homogeneous (NLDE).
65. Linear independence of solutions. The Wronskian. The Ostrogradsky–Liouville–Jacobi formula.
66. HLDE with constant coefficients. Construction of a fundamental system of solutions.
67. NLDE with constant coefficients and a right-hand side of special form.
68. Method of undetermined coefficients. All special cases.
69. Linear non-homogeneous differential equations (NLDE) of order n. Systems of differential equations.
70. Theorems on the general solutions of HLDE and NLDE.
71. Systems of differential equations. Method of variation of arbitrary constants (Lagrange's method).
72. Reduction of a system of linear differential equations to one differential equation of order n.

Working program of the academic discipline (syllabus):

Compiled by
Associate Professor of the Department of Mathematical Physics and Differential Equations, Faculty of Physics and Mathematics, PhD (Physics and Mathematics), Associate Professor Olha Sulima
Approved *by the Department of Mathematical Physics and Differential Equations, Faculty of Physics and Mathematics (minutes No. 10 of 24.06.2026)*

Agreed *by the Methodical Commission of the Faculty of Robotics and Instrument Engineering (minutes No. 6/26 of 26.06.2026)*