THE NATIONAL TECHNICAL UNIVERSITY OF UKRAINE
"Igor Sikorsky Kyiv Polytechnic Institute"

Emblem departments (if available)

Department of Mathematical Physics and Differential Equations

NAME OF THE COURSE

Higher mathematics. Part 1. Analytical geometry. Differential calculus

Working program of the academic discipline (Syllabus)

Details of the academic discipline

Level of higher education	***First (bachelor)***
Branch of knowledge	*17 Electronics, automation and electronic communications*
Specialty	*174 Automation, computer-integrated technologies and robotics*
Educational program	*Technical and software automation tools*
Status of Discipline	*Normative*
Form of education	*Full-time*
Year of training, semester	*First year, autumn semester*
Scope of the discipline	*180/ 6 credits*

	Lectures	Practical classes (seminars)	Laboratory classes (computer practice)	Individual classes	Self-study work of student
Hours	**36**	**54**	**0**	**0**	**90**

Semester control/ control measures	Exam	Test	Modular control work *(specify quantity)*	Calculation graphic work, calculation work *(specify quantity)*	Home control work *(specify quantity)*	Abstract *(specify quantity)*
	+	-	1	0	1	0

Lessons schedule	*On the website of the university, as well as the website of the Faculty of Chemical Engineering*
Language of teaching	*English*
Information about head of the course / teachers	Lecturer:: Borysenko Olga Volodymyrivna, Ph.D., associate professor of the Department of Mathematical Physics and Differential Equations, Faculty of Physics and Mathematics

	oborisenko1373@gmail.com https://intellect.kpi.ua/profile/bov114 ORCID: http://orcid.org/0000-0002-2099-2911 Practical: : Borysenko Olga Volodymyrivna, Ph.D., associate professor of the Department of Mathematical Physics and Differential Equations, Faculty of Physics and Mathematics oborisenko1373@gmail.com https://intellect.kpi.ua/profile/bov114 ORCID: http://orcid.org/0000-0002-2099-2911 Dyuzhenkova Olga Yuriivna, , Ph.D., associate professor of the Department of Mathematical Physics and Differential Equations, Faculty of Physics and Mathematics olgaduzen@gmail.com ORCID: https://orcid.org/0000-0002-8146-0134
Placement of the course	Website of the department, information resources in the library, electronic campus.

Program of educational discipline

Description of the educational discipline, its purpose, subject of study and learning outcomes

The goal of the educational discipline is the formation of students integral competence — the ability to think logically, the formation of students personalities; development of their intelligence and abilities; the ability to solve complex specialized tasks and practical problems, characterized by complexity and uncertainty of conditions, during professional activities in the field of automation, computer-integrated technologies and robotics or in the learning process; use methods of mathematical analysis in engineering calculations.

Software competencies:

General competences (GC)
GC1 Ability to think abstractly.
GC2 Ability to apply knowledge of mathematics, to the extent necessary for the use of mathematical methods for the analysis and synthesis of automation systems.

Program learning outcomes (LO)

LO1 Know linear and vector algebra, differential and integral calculus, functions of many variables, functional series, differential equations for functions of one and many variables, operational calculus, theory of functions of a complex variable, theory of probabilities and mathematical statistics, theory of random processes to the extent necessary for use of mathematical apparatus and methods in the field of automation.

Pre-requisites and post-requisites of the discipline (place in the structural and logical scheme of training according to the relevant educational program)

It is taught in the first semester on the basis of full secondary or secondary professional education. In the structural and logical scheme of the training program in this direction, the academic discipline "Higher Mathematics" precedes and provides the following academic disciplines: Physics, Chemistry, Engineering and computer graphics, Mathematical methods in automation tasks, Computer modeling of processes and systems, Discrete mathematics and basics of system analysis, Theory of automatic control, Robotics.

Content of the academic discipline

1. *Elements of linear, vector algebra and analytic geometry*. Elements of linear algebra. Vector algebra. Elements of analytical geometry on the plane and in space.
2. *Introduction to mathematical analysis*. The limit of a numerical sequence. Limits of a function of one variable. Continuity of a function of one variable.
3. *Differential calculus of a function of one variable*. Derivative of a function, differential. Derivatives and differentials of higher orders. Application of differential calculus for the study of functions and construction of their graphs.

Educational materials and resources

Basic literature

1. Дубовик В.П. Вища математика: навч. посіб. / Дубовик В.П., Юрик І.І. – К.: А.С.К., 2005. – 648 с.
2. Грималюк В.П. Вища математика: У 2 ч.: навч. посіб. / Грималюк В.П., Кухарчук М.М., Ясінський В.В. – К.: Віпол, 2004. – Ч. 1. – 376 с.
3. Дубовик В.П. Вища математика. Збірник задач: навч. посіб. / Дубовик В.П., Юрик І.І. – К.: А.С.К., 2005. – 648 с.
4. В. С. Герасимчук, Г. С. Васильченко, В. І. Кравцов. Вища математика. Повний курс у прикладах і задачах: навч. посіб. [Ч.1]. Лінійна й векторна алгебра. Аналітична геометрія. Вступ до математичного аналізу. Диференціальне числення функцій однієї та багатьох змінних. Прикладні задачі / - К.: Книги України ЛТД, 2009. - 578 с.
5. Авдєєва Т.В. Вступ до математичного аналізу. Диференціальне числення функцій однієї змінної. Навчально-методичний посібник [Електронний ресурс] /КПІ ім. Ігоря Сікорського; уклад.: Т.В. Авдєєва, О.В.Борисенко, О.Ю.Дюженкова, В.В. Листопадова. – Київ : КПІ ім. Ігоря Сікорського , 2021**.** – 84 с. https://ela.kpi.ua/handle/123456789/46065
6. Авдєєва Т.В., Листопадова В.В., Шраменко В.М. Вища математика: Лінійна алгебра. Аналітична геометрія: Розрахункова робота/ Київ , «КПІ ім.Ігоря Сікорського», 2019. – 120с. **(**електронне навчальне видання) – Режим доступу: http://kmf.kpi.ua/

Additional literature

1. Петренко М.П., Бойчук О.П., Авраменко Л.Г., Ясінський В.В. Курс лінійної алгебри та аналітичної геометрії: Учб. Посібник.- К.: ІЗМН, 2000. – 224с.
2. Стрижак Т.Г. Математичний аналіз: приклади і задачі: навч. посіб. / Стрижак Т.Г., Коновалова Н.Р. – К.: Либідь, 1995. – 240 с.
3. Клепко В. Ю. Вища математика в прикладах і задачах: навчальний посібник / В.Ю.Клепко, В.Л. Голець. – К.: Центр навчальної літератури, 2017. – 594 с.

4. Овчинников П. П. Вища математика: підруч. У 2 ч. Ч. 1. Лінійна і векторна алгебра. Аналітична геометрія. Вступ до математичного аналізу. Диференціальне і інтегральне числення / П. П. Овчинников, Ф. П. Яремчук, В. М. Михайленко. – К.: Техніка, 2003. – 600с.

Educational content

Methods of mastering an educational discipline (educational component)

5.1. Didactic materials:

In lecture classes – Lecture (electronic version), explanation, brainstorming, problem task

List of lectures

Lecture 1. Matrices. Determinants.

1.1. Concept of matrix, their classification.
1.2. Operations on matrices.
1.3. Determinants, their calculations and properties.
1.4. Minors and algebraic complements.

Lecture 2. Inverse matrix. Matrix rank.

2.1. Inverse matrix: definition, properties.
2.2. Criterion for the existence of an inverse matrix.
2.3. Algorithm for finding the inverse matrix.
2.4. Matrix equations.
2.5. The concept of matrix rank, its properties and calculation.

Lecture 3. Systems of linear algebraic equations

3.1. Systems of linear algebraic equations: basic concepts.
3.2. Solving systems of linear algebraic equations using Kramer's formulas.
3.3. Solving systems of linear algebraic equations by the matrix method.
3.4. Compatibility criterion of systems of linear algebraic equations, Kronecker-Capelli theorem.
3.5. Gauss method.
3.6. Systems of linear homogeneous equations.

Lecture 4. Vectors in space. Scalar product

4.1. Basic concepts.
4.2. Linear operations with vectors.
4.3. Vectors in a rectangular coordinate system.
4.4. Scalar product of vectors and its properties.

Lecture 5. Vector and mixed products of vectors

5.1. Vector product, its main properties.
5.2. Mixed product of three vectors, coplanarity of vectors.

Lecture 6. A straight line on a plane

6.1. The general equation of a straight line, its analysis.
6.2. The equation of a straight line in segments on the axes.
6.3. The equation of a straight line through two given points.
6.4. Canonical and parametric equation of a straight line.
6.5. The equation of a straight line with an angle coefficient.
6.6. The normal equation of a straight line. The distance from a point to a straight line.
6.7. Mutual placement of two straight lines on a plane. Angle between lines.

Lecture 7. Plane in space

7.1. The general equation of the plane, its research.
7.2. The equation of the plane in segments on the axes.
7.3. The equation of a plane passing through three given points.
7.4. Mutual placement of two planes.
7.5. Normal equation of the plane. The distance from the point to the plane.

Lecture 8. Straight in space. A straight line and a plane in space

8.1. Types of equations of a straight line in space.

8.2. Mutual placement of two straight lines in space.

8.3. Placement of the line relative to the plane.

Lecture 9. Curves of the second order on the plane

9.1. The concept of a line of the second order.

9.2. Circle, ellipse.

9.3. Hyperbola, its canonical equation.

9.4. Parabola, its canonical equations.

Lecture 10. The limit of a numerical sequence

10.1. The concept of numerical sequence.

10.2. Bounded and unbounded sequences.

10.3. Convergent sequences.

10.4. Infinitely small and infinitely large sequences.

Lecture 11. Function. The limit of a function at a point

11.1. Function. Basic concepts and definitions. Basic elementary functions.

11.2. The limit of a function at a point.

11.3. Infinitely small and infinitely large functions, the connection between them.

Lecture 12. Important boundaries. Comparison of infinitesimal functions. Equivalent functions

12.1. The first important border.

12.2. The second important limit.

12.3. Comparison of infinitesimal functions.

12.4. Equivalent infinitesimal functions.

Lecture 13. Continuity of a function. Classification of breakpoints

13.1. Continuity of a function at a point and on an interval.

13.2. Breakpoints, their classification.

13.3. Basic theorems about continuous functions.

Lecture 14. Differential calculus of functions of one variable. Derivative of a function of one variable

14.1. The concept of derivative. Geometric and mechanical content of the derivative.

14.2. Continuity and differentiability of a function.

14.3. Derivatives of basic elementary functions.

14.4. Rules for differentiating the sum, difference, product and quotient.

Lecture 15. Differentiation of functions

15.1. Differentiation of a complex function.

15.2. The derivative of the inverse function. Differentiation of inverse trigonometric functions.

15.3. Table of derivatives.

15.4. Differentiation of functions given in parametric and implicit forms.

15.5. Logarithmic differentiation. The derivative of the exponent-power function.

Lecture 16. Differential of a function. Derivatives and differentials of higher orders

16.1. Differential function, its properties.

16.2. The geometric content of the differential.

16.3. Application of the differential in approximate calculations.

16.4. Derivatives of higher orders.

16.5. Differentials of higher orders.

16.6. Taylor's formula.

Lecture 17. Basic theorems of differential calculus

17.1. Theorems of Fermat, Cauchy, Lagrange.

17.2. Lopital's rule.

Lecture 18. The application of differential calculus to the study of a function

18.1. The application of the derivative to the study of functions on monotonicity.

18.2. Finding extrema of functions.
18.3. The largest and smallest value of the function on the segment.
18.4. Convexity of the graph of the function. Inflection points.
18.5. Finding the asymptotes of the function graph.
18.6. The general scheme of the study of the function.
18.7. Examples of function research and graphing.

List of (approximate) practical classes

Practical lesson 1. Matrices, actions on them.
Practical lesson 2. Calculation of determinants.
Practical lesson 3. Inverse matrix, matrix equations. Rank calculation.
Practical lesson 4. Cramer's formulas. Matrix method.
Practical lesson 5. Gauss method. The Kronecker-Capelli theorem.
Practical lesson 6. Solving systems of linear algebraic equations (SLAE).
Practical lesson 7. Vectors in space. Scalar product.
Practical lesson 8. Vector and mixed products. Basis, expansion of a vector by basis.
Practical lesson 9. Straight on the plane.
Practical lesson 10. A plane in space.
Practical lesson 11. Directly in space. Straight and plane.
Practical lesson 12. Curves of the second order on the plane. Circle, ellipse.
Practical lesson 13. Curves of the second order on the plane. Hyperbola, parabola.
Practical lesson 14. Modular short-term control work -1 on the topic "Elements of linear, vector algebra and analytic geometry". Calculation of limits of a numerical sequence.
Practical lesson 15. Calculation of limits of functions.
Practical lesson 16. The first important limit.
Practical lesson 17. The second important limit.
Practical lesson 18. Comparison of infinitesimal functions. Equivalent functions.
Practical lesson 19. Continuity of function. Classifiction the points of Discontinuity of function.
Practical lesson 20,21. Differentiation rules and derivatives of elementary functions. The derivative of a composite function. Tangent and normal to the curve.
Practical lesson 22. Differentiation of functions given in parametric and implicit forms. Derivative of power-exponential function.
Practical lesson 23. Differential and its application. Derivatives and differentials of higher orders.
Practical lesson 24. Lopital's rule.
Practical lesson 25, 26. The application of differential calculus to the study of functions and construction of graphs.
Practical lesson 27. Modular short-term control work – 2 on the topic "Introduction to mathematical analysis. Differential calculus of a function of one variable". Final lesson.

In practical classes - Tasks to be completed (according to the specified list of basic literature).

5.2. Technical support: Microsoft Office Word, any software for the execution of graphic material (at the request of the student).

6. Self-study work of student

Types of Self-study t work - study of lecture material, preparation for classroom classes, problem solving, homework and homework control work (divided into two parts according to the semester plan certifications).

Policies and control

7. Policies of academic discipline (educational component)

Compliance with the provisions of the "Code of Honor of the National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute» (chapters 2 and 3). Read more: https://kpi.ua/code. Student cooperation in solving problem tasks is allowed, but each student defends the answers independently. Student interaction during the exam is strictly prohibited and any such activity will be considered a breach of academic integrity in accordance with the university's principles of academic integrity.

8. Types of control and rating system for evaluating learning outcomes

***Current control**:* express survey, survey on the subject of the lesson, writing MCW.

***Calendar control**:* is held twice a semester as a monitoring of the current state of fulfillment of the syllabus requirements.

Semester control: exam.

Terms of admission to semester control: a minimum positive grade for MCW, credit for homework, semester rating of at least 36 points.

The student's rating in the discipline for the 1st semester consists of the points he receives for:

1) eight answers (per student on average) in practical classes (provided that 7 students are interviewed in one lesson with a maximum group size of 25 people.
2) one modular control work;
3) one homework test;
4) the answer to the exam.

Work in practical classes

Under the condition of good preparation and active work in the practical session, the student receives 1 point. One or two best students in each practical session can be given 1 point as an incentive. The maximum number of points for all practical classes is equal to 1 point x 8 = 8 points.

Final control

One modular control work (MCW) is divided into two parts:

Modular short-term control work -1 "Elements of linear, vector algebra and analytic geometry": weighted score - 20 points;

Modular short-term control work -2 "Introduction to mathematical analysis. Differential calculus of a function of one variable": weighted score - 20 points.

(It is allowed to divide the Modular short-term control work into several thematic control papers that have the same total weighting point).

The maximum number of points for all test papers is equal to 40 points.

Home control work

Weight score – 12 points. The work is evaluated in terms of the percentage of correctly solved tasks.

Penalty and incentive points for:

- untimely (later than a week) submission of homework control work ……. – 2 points (for each week late);
- failure to perform homework and independent work …… – 1 point (for each task);
- prizes in faculty and institute Olympiads in higher mathematics; preparation and defense of reports at student scientific and practical conferences, performance of tasks to improve didactic materials from the credit module …….. + 6 points.

Calculation of the rating scale (R):

The sum of the weighted points of control measures during the semester is:

$$\mathbf{R}_S = 40 + 20 = 60 \text{ points.}$$

The examination component of the scale is equal to 40% of R, namely:

$$\mathbf{R}_E = 40 \text{ points.}$$

Thus, the rating scale for the discipline is:

$$\mathbf{R} = \mathbf{R}_S + \mathbf{R}_E = \mathbf{100} \text{ points.}$$

The size of the rating scale R=100 points.

Size of the starting scale $\mathbf{R}_S$ = 60 points.

The size of the examination scale $\mathbf{R}_E$ =40 points.

At the decision of the examiner, without an additional survey, it is possible to assign (with the student's consent) a grade of "good" ("B" or "C" in the ECTS system) in the event that the student's starting rating is at least 0.9 of the maximum possible ($\mathbf{R}_S$), that is, at $\mathbf{R}_S \geq 54$ points.

Table of correspondence of rating points to grades on the university scale:

PERSONAL SCORE	*GRADE*
100-95	Excellent
94-85	Very Good
84-75	Good
74-65	Satisfactory
64-60	Sufficiently
Personal score<60	Unsatisfactory
Personal score < 36 or the individual tasks is not credited	Not allowed to pass exam

9. Additional information on the discipline (educational component)

- *the possibility of enrolling in certificates of completion of distance or online courses on the relevant subject.*

Working program of the academic discipline (syllabus):

Compiled
Valentyna Lystopadova, Ph.D., Associate Professor
Approved: Department of Mathematical Physics and Differential Equations (Protocol №9 dated June 26, 2024)

Agreed: Methodical Commission of chemical engineering faculty (Protocol №11 dated June 28, 2024)