Національний технічний університет України
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені ІГОРЯ СІКОРСЬКОГО»

Кафедра
математичної фізики
та диференціальних
рівнянь

HIGHER MATHEMATICS. PART 1.

Working program of the academic discipline (Syllabus)

Details of the academic discipline	
Level of higher education ***First (bachelor's)***	
Branch of knowledge *14 "Electrical engineering"*	
Specialty	*141 "Electric power engineering, electrical engineering and electromechanics"*
Educational program	• *Engineering of intellectual electrical engineering and mechatronic complexes* • *Electric machines and devices* • *Electrical systems and networks* • *Electric stations* • *Electromechanical systems automation, electric drive and electromobility* • *Electrotechnical devices and electrotechnological ones complexes* • *Energy management and energy efficiency technologies* • *Non-traditional and renewable energy sources* • *Systems of providing consumers with electrical energy* • *Management, protection and automation of energy systems*
Discipline status Form of study Year of preparation, semester	*Normative* *Daytime* *First year, fall semester*
Scope of the discipline	*8 ECTS credits/ 240 hours (lectures – 72, practical classes – 72, independent work – 96)*
Semester control/ control tests activities	*exam/ MKR/ RGR*
Class schedule	*Lecture classes - 2 times a week; practical classes - 2 times a week*
Language of instruction	*Ukrainian*
Information about the course leader / teachers	Lecturer: Ph.D.-M.Sc. Andriy Leonidovych Grechko, 0980097170 Practical classes: Olena Petrivna Trofymchuk, associate professor of the Department of Mathematical Physics and Differential Equations, FMF, candidate. physics and mathematics of Sciences trofimch@imath.kiev.ua Vdovenko Tetyana Ivanivna, assistant professor of the Department of Mathematical Physics and Differential Equations of the FMF, candidate. physics and mathematics of science tanyavdovenko@meta.ua Alisa Olehivna Tsukanova, assistant professor of the Department of Mathematical Physics and Differential Equations of the FMF, candidate. physics and mathematics of science
Placement of the course	*https:// classroom.google.com/ c/ NTgxNTQ3OTE4ODA0? cjc=7br6j3d*

Program of educational discipline

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

The program of the academic discipline "Higher mathematics. Part 1" was compiled in accordance with the educational program "Electrotechnical devices and electrotechnological complexes" of bachelor's training in specialty 141 - Electric power, electrical engineering and electromechanics.

The purpose of the educational discipline is to form students of the following competencies:

K01. Ability to abstract thinking, analysis and synthesis; K02. Ability to apply knowledge in practical situations. K06. Ability to identify, pose and solve problems; K08. Ability to work autonomously; K12. The ability to solve practical problems involving the methods of mathematics and physics and electrical engineering.

Program learning outcomes, the improvement of which is aimed at the discipline: PR08. Choose and apply suitable methods for analysis and synthesis electromechanical and electric power systems with specified indicators.

PR17. Solve complex specialized problems in the design and maintenance of electromechanical systems, electrical equipment of power stations, substations, systems and networks. PR18. Be able to learn independently, acquire new knowledge and improve skills in working with modern equipment, measuring equipment and application software.

PR19. Apply suitable empirical and theoretical methods to reduce losses electric energy during its production, transportation, distribution and use.

Pre-requisites and post-requisites of the discipline (place in the structural-logical scheme of study according to the relevant educational program) To successfully master the discipline, the student must master a school course in mathematics. Competences, knowledge and skills acquired in the process of studying the credit module are necessary for further study of the disciplines "Higher mathematics. Part 2" and "Physics. Part 2".

2. Content of the academic discipline

Chapter 1. Elements of linear algebra and analytic geometry: *Topic 1.1. Algebra; Topic 1.2. Introduction to linear algebra; Topic 1.3. Analytical geometry.* ***Chapter 2. Introduction to mathematical analysis:*** *Topic 2.1. Sequence limit; Topic 2.2. Function limit and continuity; Topic 2.3. The derivative of a function and its application.*

3. Educational materials and resources

Basic literature

1. Dubovik V.P., Yurik I.I. Higher mathematics: study guide / - Kyiv.: A.S.K., 2005. - 612 p.

2. Dubovik V.P., Yurik I.I. Higher mathematics. Collection of problems / Kyiv: A.S.K., 2005. – 480 p.

3. Higher mathematics: Textbook / Dombrovsky V.A., Kryzhanivskyi I.M., Matskiv R.S., Mygovich F.M., Nemish V.M., Okrepky B.S., Khoma G.P., Shelestovska M.Ya.; edited by Shinkarik M.I. – Ternopil: Karpyuk Publishing House, 2003 - 480p. - ISBN 966-7946-15-0.

4. Collection of problems for calculation works in higher mathematics. Collection of tasks [Electronic resource]: study guide for bachelor's degree holders of the educational program "Electrical power engineering, electrical engineering and electromechanics" specialty 141 "Electrical power engineering, electrical engineering and electromechanics" / KPI named after Igor Sikorskyi; edited by: A.L. Grechko, M.E. Dudkin. – Electronic text data (1 file: 8.26 MB). – Kyiv: KPI named after Igor Sikorskyi, 2021 - 280 p. https://ela.kpi.ua/handle/123456789/41212 5. Gerasimchuk BC, Vasylchenko GS, Kravtsov VI, Higher Mathematics. Complete course in examples and problems. Volume 1. Education. manual - K.:
Books of Ukraine LTD, 2010. - 470 p. ISBN 978-966-2331-05-9.

Additional literature 6. Klepko
V.Yu., Golets V.L., Higher mathematics in examples and problems: Study guide. 2nd edition. - K.: Center of educational literature, 2009. - 594 p. ISBN 978-966-364-928-3.

7. Mathematical analysis in problems and examples: In 2 h.: Education. manual /L. I. Dyuzhenkova, T. V. Kolesnyk, M. Ya. Lyashchenko and others. — K.: Vyshcha Shk., 2002. — Part 1. — 462 p. ISBN 966-642-034-1.

8. Higher mathematics. Part 1: Linear algebra. Vector algebra. Analytical geometry. Elements of mathematical analysis. (Reference theoretical material. Solving typical problems. Training exercises with answers) [Electronic resource]: training. manual / KPI named after Igor Sikorskyi; editor: T. V. Avdeeva, O. V. Borysenko, V. M. Gorbachuk. – Electronic text data (1 file: 1.27 MB). – Kyiv: KPI named after Igor Sikorskyi, 2022. – 73 p. https://ela.kpi.ua/handle/123456789/48166 9. Higher mathematics. Differential calculus of functions of one variable. Workshop [Electronic resource]: study guide for bachelor's degree holders / N. L. Denysenko, T. O. Yeromina, V. V. Mogilova. – Electronic text data (1 file:
2.92 MB). – Kyiv: KPI named after 2022. – 159 p. https://ela.kpi.ua/handle/123456789/50361 10. Higher mathematics. Practicum Study guide / O.Yu. Dyuzhenkova, M.E. Dudkin, I.V. step by step - K.: NTUU "KPI named after Igor Sikorsky", 2021. - 409 p. – Bibliography: 409 p. - electronic edition. https://ela.kpi.ua/handle/123456789/47504
Igor Sikorsky,

Educational content

4. Methods of mastering an educational discipline (educational component)

Lecture classes

Topic 1.1. Algebra

Lecture 1. Systems of two equations with two unknowns. Determinants of the second order. Determinants of the third order and their properties. Calculation of determinants of the second and third orders.

Lecture 2. Systems of three equations with three unknowns. Cramer's formulas. The concept of determinants of higher orders. Solving systems of linear equations by the Gaussian method.

Lecture 3. Matrices and operations on them. The inverse matrix, the existence theorem of the inverse matrix.

Lecture 4. Solving systems of linear equations using the matrix method.

Matrix rank. Basic minor theorem.

Lecture 5. Elementary matrix transformations. The Kronecker-Capelli theorem. Homogeneous systems.

Topic 1.2. Introduction to linear algebra

Lecture 6. Directed segments. Coordinate system on the plane and in space. Polar coordinate system.

Lecture 7. Vectors. Basic concepts. Linear operations on vectors. Guidelines cosines of a vector. Projections and their properties.

Lecture 8. Distribution of a vector according to the coordinate basis. Linear dependence and independence of vectors.

Topic 1.3. Analytical geometry

Lecture 9. Basic problems of analytical geometry: distance between two points; division of the segment according to the given ratio; the angle between the vectors. Vector product and its properties. Area of the triangle. Mixed product and its properties. Volume of a parallelepiped.

Lecture 10. Concept of line. Algebraic lines. The geometric content of an equation of the first degree with two variables.

Lecture 11. Equations of a straight line with an angle coefficient and other equations of a straight line on plane Angle between two straight lines. Conditions of parallelism and perpendicularity of two straight lines.

Lecture 12. The concept of a second-order surface. The equation of the plane that passes through the point perpendicular to the given vector. The geometric content of the equation of the first degree with three variables.

Lecture 13. Normal equation of a plane. The distance from the point to the plane. Conditions of parallelism and perpendicularity of two planes.

Lecture 14. Canonical equations of a straight line in space. The angle between two straight lines in space. Conditions of parallelism and perpendicularity of two straight lines. The angle between a straight line and a plane.

Lecture 15. The concept of a line of the second order. Circle, ellipse, hyperbola, parabola and their properties. Derivation of hyperbola and parabola equations, their research. Optical properties curves of the second order.

Lecture 16. Surfaces of the second order. Surfaces of rotation. Cylinders, ellipsoids, hyperboloids, paraboloids, cones.

Topic 2.1. Sequence limit

Lecture 17. Real numbers. Mutually unambiguous correspondence between real numbers and points on the number line. Point sets. Quantifiers.

Lecture 18. Absolute value of a number. Properties of absolute values. Function, methods of setting it. Inverse function. Inverse trigonometric functions. Composite function. Classification of functions.

Lecture 19. Boundary of function and sequence. Properties of the boundary of the function. Endlessly small and infinitely large functions and the relationship between them. Lemmas about infinitesimal functions.

Topic 2.2. Function limit and continuity Lecture 20.

Arithmetic operations on limits. Transition to the boundary in inequality. Theorem about the intermediate variable. The existence of a limit of a bounded sequence.

Lecture 21. The first and second significant boundaries. Natural logarithms. Hyperbolic functions. Comparison of infinitesimals.

Lecture 22. Continuity of a function at a point, one-sided continuity. breaking points, their classification. Continuity of a function on an interval and on a segment. Arithmetic operations on continuous functions. Continuity of a composite function. Theorems of Cauchy and Weierstrass. Uniform continuity. Cantor's theorem.

Topic 2.3. The derivative of a function and its application

Lecture 23. Problems that lead to the concept of derivative: calculation of speed, taking a tangent. Derivative definition. Calculation of derivatives from basic elementary ones functions.

Lecture 24. Derivation of the rules for differentiation of the sum, difference, product and quotient of a function. Continuity of a function that has a derivative. Rules for calculating derivatives. Derivative of the inverse functions. Derivatives of inverse trigonometric functions.

Lecture 25. Derivative of a composite function. Derivatives of hyperbolic functions. Table derivatives Logarithmic differentiation. The derivative of the exponent-power function. One-sided derivatives. An example of a function that is continuous at a point and does not have a derivative at that point.

Lecture 26. Differentiability of a function. Differential function. Form invariance recording the differential. The geometric content of the differential. Differential of sum, product and particles Application of the differential to approximate calculations. Differentiation of functions, given parametrically.

Lecture 27. Implicit function. The derivative of an implicitly given function. Derivatives and differentials higher orders. Leibniz's formula.

Lecture 28. Non-invariance of the form of writing a differential of order higher than the first. Derivatives of higher orders of implicitly and parametrically given functions.

Lecture 29. Theorems of Fermat, Rolle, Lagrange, Cauchy. Lopital's rule.

Lecture 30. Taylor's formula. Distributions of elementary functions in the Taylor series.

Lecture 31. Equation of tangent and normal to a curve. Curve of a flat line. Calculation curves Radius and circle of curvature. Evolute and involute.

Lecture 32. Vector function of a scalar argument and its geometric interpretation. Limit and derivative of a vector function. Rules for differentiating a vector function. Equation tangent to the spatial curve and the normal plane to it.

Lecture 33. Conditions of constancy of a function. Conditions for monotonicity of the function. maximums, function minima. The extremum condition is necessary.

Lecture 34. Sufficient conditions for the extremum, which are established using the first and second derivatives. The largest and smallest value of a continuous function on a segment.

Lecture 35, 36. Convexity and concavity of curves. Inflection points, necessary and sufficient inflection condition. Asymptotes. Studying the function and constructing its graph.

Practical classes

Below is a list of practical classes, the main questions of classes coincide with subject of classes.

Practical lesson 1. Systems of two (three) linear algebraic equations with two (three) unknowns.

Practical lesson 2. Determinants of the second and third orders. Cramer's formulas. Determinants of arbitrary order. Gauss method of solving systems of equations.

Practical lesson 3. Matrices. Operations on matrices. Inverse matrix.

Practical lesson 4. Rank matrix. The Kronecker-Capelli theorem.

Practical lesson 5. Vectors. Linear operations on vectors. Directional cosines of a vector. Basis. Linear dependence and independence of vectors. The simplest problems of analytical geometry on the plane and in space. Scalar product.

Practical lesson 6. Vector product. Mixed product.

Practical lesson 7. Equation of a straight line on a plane.

Practical lesson 8. Plane.

Practical lesson 9. Straight in space.

Practical lesson 10. Plane and straight line.

Practical lesson 11. Ellipse, hyperbola, parabola.

Practical exercise 12. Surfaces of the second order.

Practical lesson 13. *MKR 1 part 1: "Linear algebra, analytic geometry."*

Structure of work:

• An example of solving a system of linear algebraic equations. • An example of calculating a scalar or vector product. • An example of constructing the equation of a straight line or a plane, the study of the second curve of order

Practical session 14. Concept of function. Area of definition and area of values.

Practical lesson 15. Inverse function. Construction of graphs of elementary functions.

Practical exercise 16. Sequence limit. Calculation of the limit of the sequence.

Practical lesson 17. The limit of a function and its calculation.

Practical exercise 18. Calculating the limit of a function using the first and second significant boundaries.

Practical lesson 19. Equivalent infinitesimals. Calculation of limits for with the help of equivalent infinitesimals.

Practical lesson 20. Continuity of a function. Classification of breakpoints.

Practical lesson 21. Calculation of derivatives of explicitly given functions.

Practical exercise 22. Calculation of derivatives of implicitly and parametrically specified functions.

Practical lesson 23. Differential of a function. Approximate calculations using differentials

Practical lesson 24. Geometric applications of derivatives.

Practical lesson 25. Derivatives and differentials of higher orders. Lopital's rule.

Practical lesson 26. Taylor's formula. Application of Taylor's formula to approximate calculations.

Practical lesson 27. Growth and decline of the function. Extreme points.

Practical lesson 28. Study of the function on convexity and concavity. points bend

Practical lesson 29-32. Asymptotes of the function graph. Construction of graphs of functions.

Practical lesson 33, 34. Complex numbers in algebraic, trigonometric and indicative forms.

Practical lesson 35. Operations on complex numbers. Moivre's and Euler's formulas.

Practical lesson 36. MKR 1 part 2: "Introduction to mathematical analysis, differential calculus of a function of one variable".

Calculation and graphic work (RGR)

As an individual task, students perform calculation and graphics work (RGR), which consists of two parts. The first part corresponds to the topic of chapter 1i consists of problems (10-15) of algebra, linear algebra and analytical geometry. The second part corresponds to section 2 and consists of the same number of problems on the boundary, continuity and derivative studies. The topics and tasks for the RGR are given in textbook [4] of the "Basic Literature" section.

Student's independent work

No s/p	*Type of independent work*	*Number hours SRS*
1	*Topic 1.1. Algebra*	*5*
2	*Topic 1.2. Introduction to linear algebra*	*5*
3	*Topic 1.3. Analytical geometry Topic*	*5*
4	*2.1. Sequence limit Topic 2.2. Limit of*	*5*
5	*a function and continuity Topic 2.3. The derivative of*	*6*
6	*a function and its application*	*6*
7 Preparation for the colloquium 9		*10*
Implementation and defense of the RGR		*20*
10 Preparation for MKR		*4*
11 Preparation for the exam		*30*
	In total	*96*

6. Control works

The purpose of the tests is to consolidate and verify theoretical knowledge from credit module, students' acquisition of practical skills of independent decision-making tasks

One modular control work (MCK) is divided into two control works duration of one hour each. Each student gets his individual option

tasks (5 tasks). The first test is done after studying chapter 1. The second the control work is carried out after studying chapter 2.

Policy and control

5. Policy of academic discipline (educational component)

The system of requirements that the teacher sets before the student:

- *rules for attending classes: in accordance with Order 1-273 dated September 14, 2020, prohibited evaluate the presence or absence of the applicant in the classroom session, including award incentive or penalty points. According to the RSO of this discipline, points are awarded are counted for the corresponding types of educational activity in lectures and practicals classes*
- *rules of behavior in classes: a student has the opportunity to receive points for appropriate types of educational activity in lectures and practical classes are provided RSO discipline. Using communication tools to search for information on Google Drive teacher, on the Internet, in a distance course on the Sikorsky platform is carried out by conditions of instruction of the teacher;*
- *policy of deadlines and rescheduling: if the student did not pass or will not appear on MKR (without good reason), its result is estimated at 0 points. Rearranging MKR results are not provided;*
- *academic integrity policy: Honor Code of the National Technical of the University of Ukraine "Kyiv Polytechnic Institute" https:// kpi.ua/ files/ honorcode.pdf establishes general moral principles, rules of ethical behavior of individuals and provides academic integrity policy for persons working and studying at the university, which they should be guided by in their activities, including when studying and composing control measures in the discipline "Modeling of electromechanical systems";*
- *when using digital means of communication with the teacher (mobile communication, e-mail, correspondence on forums and social networks, etc.) is necessary adhere to generally accepted ethical norms, in particular, be polite and restrain communication during the teacher's working hours.*

6. Types of control and rating system for evaluating learning outcomes (RSO)

Current control: *MKR, performance of RGR tasks, colloquium.*
Calendar control: *carried out twice a semester as a monitoring of the current state fulfillment of syllabus requirements.*
Semester control: *exam.*
Conditions for admission to semester control: *semester rating of more than 30 points.*
Table of correspondence of rating points to grades on the university scale:

Number of points	*Rating*
95-100	*Perfectly*
85-94	*Very good*
75-84	*Good*
65-74	*Satisfactorily*
60-64	*Enough*
Less than 60	*Unsatisfactorily*
Less than 30	*Not allowed*

The student's overall rating after the end of the semester consists of points obtained for:;

- *performance and protection of calculation and graphic work;*
- *execution of modular control works (MCR);*
- *performance of tasks at the colloquium.*

Colloquium	RGR Part 1	RGR Part 2 MKR 1	MKR 2		Additional points
10	10	10	15	15	10

Colloquium

Weight score -2. *The maximum number of points for all practical classes is 2 points * 5 questions = 10 points.*

The colloquium is held in early December and is a rehearsal for the exam. Students solve tasks and questions according to the scheme:

1. Problem on the topic of chapter 1.
2. Problem on the topic of chapter 2.
3. Theoretical question (without proof) on the topic of chapter 1. 4. Theoretical question (without proof) on the topic of chapter 2. 5. Taking the derivative function in the presence of the teacher . 30 minutes are allotted for the first two tasks. 2 minutes are allotted for questions 3-5. (for each question).

Evaluation criteria *- the question is solved correctly - 2 points; - the question was solved with errors - 1 point; - the question was solved with significant errors - 0.5 points;*

Calculation and graphic work

The weighted score is 10. *The maximum number of points for 2 parts of the RGR is 20.*

The computational and graphic work (RGR) consists of two parts, each of which is drawn up and handed in separately by the deadline determined by the lecturer (before certification).

Students who have completed the RGR within the deadline set by the teacher and completed it in accordance with the established requirements are allowed to defend for the maximum score. If the RGR is submitted for verification after the set deadline, the maximum score for the RGR defense is halved. The defense of the RGR consists of an oral examination. During the oral defense, the teacher asks questions about the content part of the RGR to determine the student's level of knowledge of the theoretical part and his understanding of problem solving methods. ***Assessment criteria for the oral stage of the RGR:*** *- timely submission of work, understanding of the presented material, complete answers to questions before the defense - 9-10 points; - timely submission of work, understanding of the presented material, answers to defense questions with some inaccuracies - 6-8 points; - - timely submission of work, incomplete understanding of the presented material, answers to defense questions with significant inaccuracies - 1-5 points. - the work is completed, but the student does not orient himself in the material at all/ the work is completed with significant errors - for revision.*

Modular control work

The weighted score for one MKR is 15. The maximum score for 2 MKR is 30 points.

Evaluation criteria *On*

the first modular test, the student must complete 5 tasks for materials of Section 1. Each task is evaluated in 3 points.

In the second modular test, the student performs 5 tasks based on the materials Section 2. Each task is evaluated in 3 points.

Calendar control is based on the current rating. A condition for a positive assessment is the value of the student's current rating of at least 50% of the maximum possible at the time of assessment.

Additional (bonus) points

The rating system provides additional points. One student cannot receive more than 10 bonus points in a semester. If more than 10 points are obtained, they are limited to 10. Bonus 1 point can be obtained exclusively at the lecture for the correct answer to a non-trivial or difficult question of the lecturer on the topic of the lecture. .

The form of semester control is an exam

The maximum number of points is 100. The condition for admission to the exam is to pass both parts of the RGR and obtain 30 points in the

rating. ***Examination paper.*** *The exam is held according to the schedule online with recording. In 2 hours, the student solves 4 questions according to the structure of*

the ticket: 1. Theoretical question according to section 1. 2. Theoretical question according to section. 3. Task on the topic of chapter 1.

4. Task on the topic of chapter 2. Each question is valued at 10 points. The first 2 questions exactly correspond to the list of exam questions.

Working program of the academic discipline (syllabus):

Compiled by A. L. Grechko, associate professor of the Department of Mathematical Physics and Differential Equations, FMF, candidate.

physics and mathematics of science **Approved by** the Department of Mathematical Physics and Differential Equations of the FMF (protocol

No. 9 dated 06.7.2023) **Agreed** by the Methodical Commission of the FEA (protocol No. 10 dated 06.22.2023)