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

Кафедра
математичної фізики
та диференціальних
рівнянь

HIGHER MATHEMATICS. PART 2.

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"*	
and **specialty** *electromechanics"*	*141 "Electric power engineering, electrical engineering*
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 electricity energy* • *Management, protection and automation of energy systems*
Discipline status Form	*Normative*
of study Year of	*Daytime*
preparation, semester	*1st year, spring semester*
Scope of the discipline	*8 ECTS credits/ 210 hours (lectures – 54, practical classes – 72, independent work – 84)*
Semester control/ control measures	*exam/ MKR/ RGR*
Class schedule	*Lecture classes - 1.5 times a week; laboratory classes - 2 times a week*
Language of	*Ukrainian*
instruction 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:// do.ipo.kpi.ua/ enrol/ index.php?id=798*

Program of educational discipline

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

The syllabus of the academic discipline "Higher Mathematics" is compiled in accordance with the educational program "Electroenergetics, electrical engineering and electromechanics" of bachelor's training in specialty 141 - Electrical energy, 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.

Prerequisites 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 have a school mathematics course and a full course of higher mathematics of 1 semester. Competences, knowledge and skills obtained in the process of studying the credit module are necessary for further study of the disciplines "Elements of operational calculus and field theory" and "Physics".

2. Content of the educational discipline

Section 1. Integration of functions of one variable and differential calculus of functions of many variables *Topic 1.1. Indefinite integral Topic 1.2. The definite integral and its application Topic 1.3. Improper integral Topic 1.4 Differential calculus of functions of many variables*

Section 2. Differential equations and series *Topic 2.1. Differential equations of the first order Topic 2.2. Differential equations of higher orders Topic 2.3. Number series Topic 2.4 Power series*

3. Educational materials and resources

Main literature Dubovik

1. V.P., Yuryk 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 / V.A. Dombrovskyi, I.M. Kryzhanivskyi, Matskiv R.S., Mygovych F.M., Nemish V.M., Okrepkyi B.S., Homa G.P., Shelestovska M.Ya.; by edited by Shinkarik M.I. – Ternopil: Karpyuk Publishing House, 2003 - 480p. - ISBN 966-7946-15-0.

4. A collection of problems for calculation works in higher mathematics. Collection of tasks [Electronic resource]: study guide for bachelor's degree holders in education by the program "Power Engineering, Electrical Engineering and Electromechanics" specialty 141 "Electroenergetics, electrical engineering and electromechanics" / KPI named after Igor Sikorskyi; structure.: 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. BC Gerasimchuk, GS Vasylchenko, VI Kravtsov, Higher Mathematics. Full course in examples and problems. Volume 2. Education. manual - K.: Books of Ukraine LTD, 2010. - 470 p. ISBN 978-966-2331-05-9.

Additional literature

6. V. Yu. Klepko, V. L. Golets, 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 hrs.: 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. Exercise tasks with answers) [Electronic resource]: education 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 Sikorsky, 2022. – 73 p. https://ela.kpi.ua/handle/123456789/48166

9. Higher mathematics. Differential calculus of functions of one variable. Practicum [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 Mbyte). – Kyiv: KPI named after Igor Sikorsky, 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 with. - electronic edition. https://ela.kpi.ua/handle/123456789/47504

Educational content

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

Lecture classes

Topic 1.1. Indefinite integral

Lecture 1. Primitive function. The indefinite integral, its properties. Integration for by changing the variable in the indefinite integral. Table of integrals.

Lecture 2. Integration by parts. Some recurrence formulas. Integration of fractional rational functions. Integration of expressions with quadratic trinomials.

Lecture 3. Integration of irrational expressions. Integration of binomial differentials. Chebyshov's theorem.

Lecture 4. Integration of expressions containing trigonometric functions. Examples of elementary functions whose primitives are not elementary functions. ***Topic 1.2. The definite integral and its application Lecture 5.*** Problems that lead to the concept of the definite integral. Definition of the definite integral. Sufficient conditions for the integration of the function. Properties of the definite integral.

Lecture 6. The definite integral as a function of the variable upper limit of integration. Continuity of this function, its differentiation. Newton-Leibniz formula. Changing the variable in the definite integral. Integration by parts in a definite integral.

Lecture 7. Calculation of the areas of figures in the Cartesian coordinate system. The area of the figure in the polar coordinate system. Calculation of the volume of a body based on the known areas of its parallel sections. Volume of the body of rotation.

Lecture 8. Straightness of a plane curve. The length of the arc of a flat curve in different ways of its specification. Arc length of the spatial curve. Elliptic integrals. Calculation of the surface area of rotation. Static moments and coordinates of the center of mass of a material arc and a material flat figure. Papp-Guldin theorems. Moments of inertia. ***Topic 1.3. Improper integral Lecture 9.*** Improper integrals of bounded functions over an unbounded interval (of the first kind). The main meaning. Sufficient signs of convergence and divergence of improper integrals of the first kind from positive functions. Absolute convergence. Improper integrals of unbounded functions over a bounded interval (of the II kind). The main meaning. Sufficient signs of convergence and divergence of improper integrals of the II kind from positive functions. Absolute convergence. ***Topic 1.4 Differential calculus of functions of many variables Lecture 10.*** Determination of the Euclidean distance between two points in multidimensional space; neighborhood; internal, boundary and external points of the set; open and closed set; region. The concept of a function of several variables. Continuity at a point, in a region, in a closed region. Theorems of Cauchy and Weierstrass on continuous functions: formulation and interpretation.

Lecture 11. Partial derivatives of the first order: definition, geometric interpretation for a function of two variables. Differentiability of a function of several variables at a point: definition, necessary condition, sufficient condition. Complete differential and its use in approximate calculations. The derivative of a composite function. Full derivative.

Lecture 12. Tangent plane and normal to the surface. Geometrical interpretation of the complete differential of a function of two variables. Implicit function. Theorem on the existence of an implicit function. Theorem on the differentiation of an implicit function. Derivatives of higher orders. Theorem on mixed derivatives. Differentials of higher orders.

Lecture 13. Taylor's formula for a function of several variables. The extremum of a function of several variables. Necessary conditions for the extremum of a function of several variables. Sufficient conditions. The largest and smallest value of a function that is continuous in a bounded closed region. Conditional extremum. Lagrange function method. ***Topic 2.1. Differential equations of the first order***

Lecture 14. Problems that lead to differential equations. Basic concepts. Cauchy's problem. The theorem of the existence and unity of the solution of the Cauchy problem for a differential equation of the first order. Special junctions. Field of directions. Isoclines. Method of successive approximations.

Lecture 15. Differential equations of the first order with separable variables.
Differential equations homogeneous with respect to variables and reducible to them.

Lecture 16. Linear differential equations. Bernoulli's equation. Equations in complete
differentials

Topic 2.2. Differential equations of higher orders Lecture 17.

Differential equations of higher orders. Cauchy's problem. Theorem on the existence and unity of the solution. Some types of higher-order differential equations that
allow decreasing order.

Lecture 18. Linear differential equations of arbitrary order. Linear differential operators, their properties. Theorem on the structure of the general solution of a linear homogeneous differential equation of arbitrary order with continuous coefficients. Theorem on the structure of the general solution of a linear inhomogeneous differential equation of arbitrary order. Ostrogradsky-Liouville formula.

Lecture 19. Linear homogeneous differential equation of the nth order with constant real coefficients. Characteristic equation. Finding a general solution in all cases. A linear inhomogeneous differential equation of the nth order with constant coefficients and a special right-hand side.

Lecture 20. The method of variation of arbitrary constants for solving linear inhomogeneous differential equation of the nth order. Systems of differential equations.

Lecture 21. Concept of stability of solutions of differential equations. Determination of stability and asymptotic stability according to Lyapunov. Stability of the zero solution of the system of linear differential equations with constant coefficients. Raus-Hurvitz criterion. Lyapunov functions. Lyapunov's theorems on stability and asymptotic stability.

Lecture 22. Elements of the qualitative theory of differential equations. Classification of special points Limit cycle. Poincaré theorems. The concept of chaos. ***Topic 2.3.***

Number series Lecture 23.

Number series. Convergence and sum of a number series. Convergence condition is necessary. Properties of numerical series. Series with positive terms. Comparison theorem. Signs of convergence of Dalembert and Cauchy. Cauchy's integral sign.

Lecture 24. Variable number series. Absolute and conditional convergence. Alternate rows sign. Leibniz's theorem. Properties of absolutely convergent series. Riemann's theorem. Multiplication of series. Cauchy's theorem. Series with complex members.

Topic 2.4 Power series

Lecture 25. Definition of a functional series. Area of convergence. Uniform convergence. Weierstrass sign. Theorem on the continuity of the sum of a functional series. Theorems on term-wise integration and differentiation of functional series. The concept of a power series. The interval and radius of convergence of the power series. Power properties

rows Theorem on the unity of the expansion of a function into a power series.

Lecture 26. Taylor series. A necessary and sufficient condition for the expansion of a function into a Taylor series. Schedule of basic elementary functions. Application of power series to approximate calculations. Approximate integration of differential equations.

Lecture 27. Fourier series. Formulas for the coefficients of the Fourier series. Signs of convergence of the Fourier series. Examples of the distribution of functions in the Fourier series. Distribution of even and odd functions into a Fourier series. The complex form of the Fourier series.

Practical classes

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

Practical exercise 1. Calculation of indefinite integrals using the table of basic integrals and integration rules. Changing the variable in the indefinite integral. Integration by parts.

Practical lesson 2, 3. Integration of rational functions.

Practical lesson 4. Integrating expressions that contain trigonometric functions.

Practical lesson 5-6. Integration of irrational expressions. Integration of binomial differentials.

Practical lesson 7-8. Newton-Leibniz formula. Substitution of a variable in a defined integrals Integration by parts in a definite integral.

Practical exercise 9. Calculation of areas of flat figures.

Practical lesson 10, 11. Calculation of volumes of bodies. Calculation of the length of the arc of the curve. Surface area.

Practical lesson 12. Improper integrals of the first kind. Improper integrals second kind

Practical lesson 13. Functions of several variables, domain, limit, continuity First order partial derivatives and total differential.

Practical lesson 14. Derivatives of complex and implicit functions. Tangent plane and normal to the surface.

Practical lesson 15, 16. Extrema of functions of several variables. Conditional extreme The largest and smallest value of a continuous function in a closed region.

Practical lesson 17. Differential equations of the first order: z separable variables, homogeneous.

Practical lesson 18, 19. Differential equations of the first order: linear, Bernoulli, in complete differentials.

Practical exercise 20. Differential equations of higher orders that admit decreasing order.

Practical exercise 21. Linear homogeneous differential equations of higher orders with constant coefficients.

Practical lesson 22, 23. Linear inhomogeneous differential equations of higher order

of orders with constant coefficients.

Practical lesson 24. Integration of linear heterogeneous differentials equations of higher orders by the method of variation of arbitrary constants.

Practical lesson 25. Integration of systems of differential equations.

Practical lesson 26, 27. Numerical series with positive terms. Research convergence of series using the signs of comparison, Dalembert, radical and integral signs of Cauchy.

Practical lesson 28. Functional series. Area of convergence. Uniform convergence.

Practical lesson 29. Power series. Interval of convergence.

Practical lesson 30. Taylor's series. Expansion of a function into a Taylor series.

Practical lesson 31, 32. Application of power series. Approximate calculations.

Practical lesson 33, 34. Distribution of functions in the Fourier series.

Practical exercise 35. Distribution of functions in the Fourier series by sines and cosines. The complex form of the Fourier series.

Practical lesson 36. MKR on the topics of the entire semester.

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 1 and consists of problems (10-15). The second part corresponds to section 2 and consists of the same number of tasks. The topics and tasks for RGR are given in the textbook [4] of the section "Main literature".

Student's independent work

No s/p	*Type of independent work*	*Number hours SRS*
1	*Topic 1.1. Indefinite integral Topic 1.2. The*	*4*
2	*definite integral and its application Topic 1.3. Improper integral Topic 1.4*	*4*
3	*Differential calculus of functions of many*	*4*
4	*variables Topic 2.1. Differential equations of the first order Topic 2.2. Differential*	*4*
5	*equations of higher orders Topic 2.3. Numerical series Topic 2.4 Power*	*4*
6	*series 9 Implementation and protection of RGR*	*4*
7		*4*
8		*4*
		20
10 Preparation for MKR		*2*
11 Preparation for the exam		*30*
	In total	*84*

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 test (MKR) lasting one hour (90 min.). Everyone the student receives his individual version of tasks (5 tasks). Structure and oriented problem examples are announced by the teacher at the penultimate lesson, the MKR itself is held in the last lesson.

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, test.*
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 on the test.*

Test	*RGR Part 1*	*RGR Part 2 of the ICR*		*Additional points*
10	*10*	*10*	*30*	*10*

Test

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

The test is conducted during practical classes when the student solves problems.

Evaluation criteria

- the question was 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 point is 10. *The maximum number of points for 2 parts of the RGR is 20.*

Calculation 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 are in the specified age are allowed to defend for the maximum score the teacher completed the RGR and issued it in accordance with the established requirements. When passing the RGR for verification after the set deadline, the maximum point for protecting the RGR is awarded is halved. The defense of the RGR consists of an oral examination. During oral defense the teacher asks questions on the content part of the RGR to determine the student's level of knowledge theoretical part and his understanding of problem solving methods. ***Evaluation criteria for the oral stage of the RGR:***

- timely submission of work, understanding of the presented material, complete answers to defense questions - 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 for defense questions with significant inaccuracies - 1-5 points.
- the work is completed, but the student does not orient himself in the material/ work at all made with significant errors - for revision.

Modular control work

The weighted score for the MKR is 30. The maximum score for the MKR is 30 points.

Evaluation criteria

In the modular control work, the student must complete 5 tasks based on the materials Chapter 1 and Chapter 2. Each task is worth 6 points.

Calendar control is based on the current rating. By condition positive attestation is the value of the student's current rating of at least 50% of as much as possible at the time of certification.

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. At the request of the student

the exam from the credit module "automatically" takes place by multiplying the rating points by , students who have points less than 36 and those who wish to improve their grade in the ECTS system perform the exam work. The final grade is formed by adding the points of the rating to the points of the examination work.

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 chapter 1. 2. Theoretical question according to chapter 2.. 3. Problem according to the topic of chapter 1. 4. Problem according to the topic of chapter 2.*

Each question is evaluated in 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 Faculty (protocol No. 10 dated 06.22.2023)