National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Department of Mathematical Analysis and Probability Theory
Probability

Higher Mathematics. Part 1. Differential and Integral Calculus of Functions of One Variable

Work program for the credit module of the academic discipline "Higher Mathematics. Part 1. Differential and Integral Calculus of Functions of One Variable" (Syllabus)

Details of academic discipline

Level of higher education First (bachelor's)

Field of knowledge	17 Electronics, Automation, and Electronic Communications
Special	172 Electronic communications and radio engineering
Educational program	**1. Intelligent technologies of radio electronics** **2. Information and Communication Radio Engineering** **3. Radio Engineering Computerized Systems** **4. Radio Electronic Warfare Technologies**
Status of the discipline	Regulatory
Form of study	Full-time (day)/distance
Year of training, semester	1st year, fall semester
Scope of the discipline	120 hours (36 hours – Lectures, 36 hours – Practical lessons, 48 hours – Independent study)
Semester control/control measures	Exam/written exam
lesson schedule	http://rozklad.kpi.ua
Language of instruction	Ukrainian
Information about the course supervisor/teachers	**Lecturer**: Candidate of Physical and Mathematical Sciences, Associate Professor of the Department of Mathematical Analysis and Probability Theory, Oleksandr Oleksandrovych Dykhovychnyi, a.dyx@ukr.net , mobile +38(067)9005262
	Practical: Anna Oleksiyivna Maslyuk, Candidate of Physical and Mathematical Sciences, Senior Lecturer, Department of Mathematical Analysis and Probability Theory, masliukgo@ukr.net Kroshko Natalia Vitalievna, Candidate of Physical and Mathematical Sciences, Associate Professor of the Department of Mathematical Analysis and Probability Theory, kroshkonatasha@gmail.com Tetiana Volodymyrivna Malovychko, PhD in Physics and Mathematics, Associate Professor of the Department of Mathematical Analysis and Probability Theory, tatianamtv@protonmail.com
Course placement	https://do.ipo.kpi.ua/course/view.php?id=5241

Curriculum

1. Description of the academic discipline, its purpose, subject matter, and learning outcomes

Description of the discipline	In accordance with the curriculum, the credit module "Higher Mathematics. Part 1. Differential and Integral Calculus of Functions of One Variable" is included in the academic discipline "Higher Mathematics" (GN 7) belongs to the cycle of mathematical and natural science training and is of paramount importance in the training of specialists. It is necessary for the successful mastery of special disciplines. This credit module is based on the knowledge students have acquired while studying mathematics in secondary school. The discipline "Higher Mathematics" is one of the fundamental general education disciplines that form the theoretical basis for the training of engineers and programmers. The knowledge and skills acquired by students while studying this discipline are used in the future when studying many subsequent disciplines of professional training of specialists with basic and complete higher education. When studying this discipline, students will learn about: functions of one variable (domain, range, types and methods of defining functions, basic characteristics of functions, basic elementary functions and their graphs); the basics of differential calculus of functions of one variable (limit of a numerical sequence, limit of a function, first and second definite limits, equivalent infinitely small functions, continuity of a function, points of discontinuity, tangent and normal to a curve, derivative and differential of a function, asymptotes of a function graph, extremum of a function, L'Hôpital's rule, construction of function graphs); basics of integral calculus of functions of one variable (primitive, indefinite integrals).
Objectives of the discipline	The aim of the course is to: • to develop logical thinking, intellect, and abilities in students; • to develop the necessary intuition and erudition in the application of mathematics, to cultivate in students applied mathematical culture; • developing the ability to independently use and study literature on mathematics, developing flexibility thinking, creative independence, and action.
Subject of the academic discipline	General mathematical properties and patterns. Functions of one variable, basics of differential calculus of functions of one variable, the basics of integral calculus of functions of one variable.

Competencies	The aim of academic discipline is to develop students' abilities: • the ability to think abstractly, analyze, and synthesize (GC 1); • ability to apply knowledge in practical situations (PC 2); • Ability to learn and acquire modern knowledge (PC 07); • ability to identify, pose, and solve problems (GC 08);
Program learning outcomes	Apply fundamental and applied sciences to analyze and develop processes occurring in telecommunications and radio engineering systems (PRO13)

2. **Prerequisites and post-requisites of the discipline (place in the structural-logical scheme of training under the relevant educational program)**

Post-requisites: "Higher Mathematics" is part of the cycle of mathematical and natural science training and has a dominant role in the training of specialists and precedes educational component
"Computer Science" and "Programmable Tools in Intelligent Radio Electronics."

3. Content of academic discipline

Names of sections and topics	**Number of hours**			
	Total	**including**		
		Lectures	**Practical**	**SRC**
1	***2***	***3***	***4***	***5***
Section 2. *Differential calculus of functions of one variable*				
Topic 2.1. Introduction to mathematical analysis	**24**	**10**	**10**	**2**
Topic 2.2. Differential calculus and its applications	**32**	**14**	**14**	**2**
Topic 2.3. Indefinite integral	**26**	**12**	**10**	**2**
Test on Section 2	**8**	**–**	**2**	**6**
Home test	6	–	–	6
Exam	**30**	**–**	**–**	**30**
Total hours	120	36	36	48

4. **Teaching materials and resources**

5. **Basic literature**

1. Mathematics at a Technical University: Textbook./ I.V. Alekseeva, V.O. Gaidei, O.O. Dykhovichnyi, L.B. Fedorova; edited by O.I. Klesov; Igor Sikorsky Kyiv Polytechnic Institute, - Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2018. – Vol. 1. – 496 p.
http://ela.kpi.ua/handle/123456789/24338

2. Mathematics at a Technical University: Textbook./ I.V. Alekseeva, V.O. Gaidei, O.O. Dykhovichnyi, L.B. Fedorova; edited by O.I. Klesov; Igor Sikorsky Kyiv Polytechnic Institute, - Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2019. – Vol. 2. – 504 p.
https://ela.kpi.ua/handle/123456789/30396
3. Mathematics at a Technical University: Textbook./ I.V. Alekseeva, V.O. Gaidei, O.O. Dykhovichnyi, L.B. Fedorova; edited by O.I. Klesov; Igor Sikorsky Kyiv Polytechnic Institute, - Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2021. – Vol. 3. – 456 p.
https://ela.kpi.ua/handle/123456789/39003
4. Dubovyk, V. P. Higher Mathematics / V. P. Dubovyk, I. I. Yurik. — Kyiv: Ignatex-Ukraine, 2013. — 648 p.
5. Mathematics in a Modern Technical University. Practical Workbook. Part 2. Differential and Integral Calculus of Functions of One Variable [Electronic resource]: textbook for students of higher educational institutions / I. V. Alekseeva, V. O. Gaidei, O. O. Dykhovichnyi [et al.]. – Electronic text data (1 file: 3.67 MB). – Kyiv: NTUU "KPI", 2015. – 249 p. https://ela.kpi.ua/handle/123456789/16620
6. Dubovyk, V. P. Higher Mathematics. Collection of Problems: Textbook / V. P. Dubovyk, I. I. Yurik. – Kyiv: A.S.K., 2005. – 648 p.
7. Adams R. A. Calculus: Complete course / R. A. Adams, C. Essex. — Toronto: Pearson Canada, 2010. — 1076 pp.

Supplementary literature

8. Zill D. G. Advanced engineering mathematics / D. G. Zill, W. S. Wright. — Burlington : Jones and Bartlett Learning, 2017. — 1004 pp.
9. Zill D. G. Calculus: Early Transcendentes / D. G. Zill, W. S. Wright. — Sudbury: Jones and Bartlett publishers, 2011. — 994 pp.
10. All Higher Mathematics / M. L. Krasnov, A. I. Kiselev, G. I. Makarenko et al. — Moscow: Editorial URSS, 2017. — Vol. 2—4.
11. Pismenny D. Lecture notes on higher mathematics: Complete course / D. Pismenny. — Moscow: Iris Press, 2014. — 608 p.
12. Mathematics at a technical university: Practical exercises: In 4 parts / I. V. Alekseeva, V. O. Gaidei, O. O. Dykhovichnyi, L. B. Fedorova. — Kyiv: NTUU KPI, 2014. — 752 p.
13. Berman G. N. Collection of problems on the course of mathematical analysis / G. N. Berman. — St. Petersburg: Lan, 2017. — 492 p.

Information resources Distance learning courses:

1. Mathematics for Engineers and Economists. Differential Calculus of Functions of One Variable. Course for bachelors of technical and economic specialties. Lectures, practice, video lectures Alekseeva I.V., Gaidey V.O., Dykhovichny O.O., Fedorova L.B., Konovalova N.R., Dudko A.F.

http://moodle.ipo.kpi.ua/moodle/course/view.php?id=960

2. Mathematics for engineers and economists. Integral calculus of functions of one variable. Course for bachelor's degree students in technical and economic specialties. Lectures, practical lessons, video lectures. Alekseeva I.V., Gaidey V.O., Dykhovichny O.O., Fedorova L.B., Konovalova N.R., Dudko A.F., Moskvichova K.K.

http://moodle.ipo.kpi.ua/moodle/course/view.php?id=1249

Educational content

6. Methodology for mastering the academic discipline (educational component) Full-time/distance learning

Lectures

No	Lecture topic and list of key questions
No	(list of teaching aids, references to literature, and assignments for independent study)

1	Introduction. Sets and operations on them. Sets of real numbers. Bounded numerical sets, the concept of the upper and lower bounds of a set. Mathematical shorthand: the use of mathematical logic symbols for abbreviated notation of mathematical statements. *Recommended literature:* [1], 1.2.
2	Numerical functions. Basic concepts. Ways of defining a function. Inverse function. Composite function. Basic characteristics of function behavior. Recommended reading: [2], 5.1-5.6
3	Limit of a function at a point. Infinitely small and infinitely large functions. Finding the limit of a function. "Certainty" and uncertainty *Recommended reading:* [2], 6.1.
4	Numerical sequence. Limit of a sequence. Limit of a bounded monotonic sequence. *Recommended reading:* [2], 6.2
5	Properties of limits. Operations on finite limits. The first limit and its consequences. The second limit and its consequences. *Recommended reading:* [2], 6.3.
6	Continuity of a function at a point and on an interval. Definition of continuity of a function. Concept of points of discontinuity of a function and their lessonification. Basic theorems about functions that are continuous on an interval. *Recommended reading:* [2], 6.4.
7	Derivative of a function. Problems leading to the concept of a derivative. Definition of a derivative, its geometric and physical meaning. Rules for calculating a derivative. Derivatives of basic elementary functions. Methods of differentiation. Derivative of a composite and inverse function. Logarithmic differentiation. Differentiation of implicitly and parametrically defined functions. *Recommended reading:* [2], 7.1.
8	Differential of a function. Derivatives and differentials of higher orders. The concept of the differential of a function and its geometric meaning. Properties of the differential and their use in approximate calculations. Definitions of derivatives and higher-order differentials and their properties. Leibniz's formula. *Recommended reading:* [2], 7.2.
9	Fundamental theorems of differential calculus. Theorems of Fermat, Rolle, Lagrange, and Cauchy. Bernoulli–L'Hôpital's rule and its use in revealing the main types of indeterminacies. *Recommended reading:* [2], 7.3.
10	Taylor's formula. The concept of a Taylor polynomial and its remainder term in Peano form. Derivation of Maclaurin formulas for basic elementary functions. Use of Taylor's formula in approximate calculations. *Recommended reading:* [2], 7.4.
11	Studying functions using the first derivative. Defining the monotonicity of a function on an interval. Necessary and sufficient conditions for the monotonicity and constancy of a function on an interval. Necessary and sufficient conditions for the extremum of a function at a point. Studying a function using the second derivative. Definition of a convex function and a point of inflection. Necessary and sufficient conditions for convexity of a function on an interval and a point of inflection. Asymptotes of a function graph and methods for finding them. *Recommended reading:* [2], 7.5.
12	General scheme for studying a function and constructing a graph. Examples. *Recommended reading:* [5], 7.5.
13	Primitive and indefinite integrals. The concept of a primitive and its properties, examples. Definition of an indefinite integral and its properties. Table of basic integration formulas. *Recommended reading:* [3], 9.1.
14	Basic methods of integration. Reduction to a table. Integration by parts. Integration by substitution. *Recommended reading:* [3], 9.2.

15	Rational functions and their decomposition into a sum of simplest fractions. Theorem on the decomposition of a regular rational function (without proof), examples. Integration of rational functions. Methods of integration of four types of simplest fractions. Methods of indeterminate coefficients. *Recommended reading:* [3], 9.3.
17	Integration of trigonometric expressions. Universal substitution and its application. Trigonometric substitutions and their varieties. Consideration of cases for which universal substitution is irrational. *Recommended reading:* [1], 9.4.
18	Integration of irrational expressions. Chebyshev's Chebyshev on integration of differential binomials. Consideration of the case of quadratic irrationality. *Recommended reading:* [1], 9.5.

Practical lessons

No No	Name of the topic and list of main questions (list of teaching aids, references to literature, and assignments for independent study)
1	Sets and operations with them. Independent study tasks: [5], p. 77.
2	Numerical functions. Assignments for independent study: [5], p. 77.
3	Limits of functions. Assignment for independent study: [5], p. 84.
4	Limit of a sequence. Assignment for independent study: [5], p. 92.
5	Infinitely small and infinitely large functions. Homework assignment: [5], p. 92.
6	Continuous functions. Points of discontinuity. Assignment for independent study: [5], p. 107. Module test -1 "Introduction to Mathematical Analysis"
7	Derivatives of functions. Assignment for independent study: [5], p. 115.
8	Methods of differentiation. Differential of a function and its application Assignment for independent study: [5], p. 126.
9	Derivatives and higher-order differentials. Bernoulli–L'Hôpital's rule. Assignment for independent study: [5], p. 134.
10	Taylor's formula. Assignment for independent study: [5], p. 139.
11	Investigating a function using the first derivative. Assignment for independent study: [5], p. 144.
12	Studying functions using second derivatives, plotting function graphs. Assignment for independent study: [5], p. 150.
13	Module test -2 "Differential calculus of functions of one variable"
14	Indefinite integral. The simplest methods for finding primitives. Assignment for independent work: [5], p. 159.
15	Basic methods of integration. Assignment for independent study: [5], p. 167.
16	Integration of rational functions. Assignment for independent study: [5], p. 173.

17	Integration of trigonometric expressions. Assignment for independent study: [5], p. 182.
18	Integration of irrational expressions. Assignment for independent study: [5], p. 186. Module test -3 "Integral calculus of functions of one variable."

No No	Name of the topic and list of main questions (list of teaching aids, references to literature, and assignments for independent study)
1	Sets and operations with them. Independent study tasks: [5], p. 77.
2	Numerical functions. Assignments for independent study: [5], p. 77.
3	Limits of functions. Assignment for independent study: [5], p. 84.
4	Limit of a sequence. Assignment for independent study: [5], p. 92.
5	Infinitely small and infinitely large functions. Homework assignment: [5], p. 92.
6	Continuous functions. Points of discontinuity. Assignment for independent study: [5], p. 107. Module test -1 "Introduction to Mathematical Analysis"
7	Derivatives of functions. Assignment for independent study: [5], p. 115.
8	Methods of differentiation. Differential of a function and its application Assignment for independent study: [5], p. 126.
9	Derivatives and higher-order differentials. Bernoulli–L'Hôpital's rule. Assignment for independent study: [5], p. 134.
10	Taylor's formula. Assignment for independent study: [5], p. 139.
11	Investigating a function using the first derivative. Assignment for independent study: [5], p. 144.
12	Studying functions using second derivatives, plotting function graphs. Assignment for independent study: [5], p. 150.
13	Module test -2 "Differential calculus of functions of one variable"
14	Indefinite integral. The simplest methods for finding primitives. Assignment for independent work: [5], p. 159.
15	Basic methods of integration. Assignment for independent study: [5], p. 167.
16	Integration of rational functions. Assignment for independent study: [5], p. 173.
17	Integration of trigonometric expressions. Assignment for independent study: [5], p. 182.
18	Integration of irrational expressions. Assignment for independent study: [5], p. 186. Module test -3 "Integral calculus of functions of one variable."

7. Independent work of students/graduate students

The study of the discipline includes the following types of independent work:

- preparation for lectures and practical lessons, completion of homework assignments;
- completion of homework assignments (test tasks in distance learning courses on the Moodle platform);
- preparation and completion of modular assignments;
- preparation for the exam.

Assignments

One Module test is planned, which is divided into two tests on topics 2 and 3:

1. Module test -1. "Introduction to mathematical analysis."
2. Module test -2. "Differential calculus of functions of one variable."
3. Module test -3. "Integral calculus of functions of one variable."

The purpose of the Module test s is to assess the level of mastery of the relevant modules and to calculate points according to the credit-modular system of modules.

Policy and control

8. Policy of the academic discipline (educational component)

Recommended learning methods: studying the main and supplementary literature on the topics of the lectures, solving problems in practical lessons and when doing homework.
Students are advised to take detailed notes during lectures. An important aspect of effective learning, practicing methods and algorithms for solving basic problems in the discipline is independent work. It includes reading literature, reviewing literature on the topic, preparing for lessons, completing homework assignments, preparing for midterm and final exams.

Academic integrity

The policy and principles of academic integrity are defined in Section 3 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute." For more details, see: https://kpi.ua/code

Standards of ethical behavior

The standards of ethical conduct for students and employees are defined in Section 2 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute." For more information, please visit: https://kpi.ua/code

9. Types of control and rating system for assessing learning outcomes (RSA) (full-time/distance learning)

Distribution of study time by type of lesson and assignment in accordance with the working curriculum.

Semester	Study time		Distribution of teaching hours				Control measures		
	Credits	academic hours	Lectures	Practical	Lab work	SRS + Ex.	MODULE TEST	DCR	Semester assessment
1	4	120	36	36	-	48	1	1	copy

A student's grade for a course consists of points awarded for

1) answers in practical lessons;
2) one test (the Module test can be divided into several tests);
3) one HCW
4) answers on the exam.

The size of the rating scale is R = 100 points. The size of the starting scale is $_{RC}$ = 50 points. The size of the exam scale is $_{RE}$ = **50 points.**

Rating (weighting) point system and assessment criteria

1. Work in practical lessons

Weighted score –15. The maximum number of points for all practical lessons is 15 points.

0.0 – refusal to answer, lack of knowledge of the necessary theoretical material;

0.25 – knowledge of individual fragments of theoretical material, ability to apply some of them;

0.5 – superficial knowledge of theoretical material, solving problems with the help of the teacher;

0.75 – good knowledge of theoretical material, ability to apply it;

1 – perfect knowledge of theoretical material, almost independent problem solving

2. Module test

Weighting score -20. The maximum number of points for all tests is 20 points. Module test assessment criteria: absence from the test – 0 points,

The Module test score (in points) is equal to the percentage (of the maximum number of points, 20) of its completion. If the completion rate is less than 60%, the test is not counted.

3. Home test (HT). Divided into 3 HTs: HT1, HT2, HT3. Weighted score – 15.

HT assessment criteria:

Failure to complete the HTA – 0 points. The HT is completed and defended in parts that correspond in content to the Module test. This part of the HT is submitted before the MTA is written, and the MTA itself is its defense.

The HCW assessment (in points) is equal to the percentage (of the maximum number of points, 15) of its completion, taking into account the result of writing the corresponding taking into account the result of writing the corresponding. If less than 60% of the HCW is completed, it is not counted. For late submission (more than a week late) of the HCW, no more than 60% will be credited.

4. Exam answer Weighted score – 50.

The number of exam rating points is equal to the percentage (of the maximum score of 50) of the exam work completed. If less than 60% (<30 points) of the exam work is completed, it will not

and must be rewritten.

Bonus points are awarded for successful performance in the mathematics Olympiad (maximum 5 points per semester).

Conditions for a positive interim assessment.

To receive a "pass" on the first interim assessment (week 8), the student must have at least 50% of the planned number of points. To receive a "pass" on the second interim assessment (week 14), the student must also have less than 50% of the planned number of points.

If a student is unable to write a Module test for valid reasons, they are given the opportunity to rewrite it within the next two weeks.

Retaking a positive final semester assessment in order to improve it is not permitted.

A student is admitted to the exam if their semester rating is not less than 30 points, and they have at least one positive assessment, credited Module test s, and a typical calculation (completed not at least 60%).

If the semester grade is less than 30 points but greater than 20, the student may write a qualifying exam. test exam. If the test is passed (at least 60% of the problems are solved correctly), the semester grade will be 30 points.

Table for converting the rating assessment for the academic discipline R: *(according to Table 1)*

$R = R_I + R_E$	**ECTS grade**	**Traditional grade**
95	A	Excellent
85	B	very good
75	C	Good
65...74	D	satisfactory
60...64	E	sufficient
$R \le 60$	Fx	unsatisfactory
$R_I < 30$ or other conditions for admission to the exam	F	not admitted

10. Additional information on the discipline (educational component)

During the legal regime of martial law, the educational process at Igor Sikorsky KPI for full-time and part-time higher education students is conducted remotely. In the case of distance learning, the educational process is organized using e-mail, Telegram, video conferences in Zoom, and the Moodle educational platform. Current control can be carried out in the form of test control works in Moodle. The RSA may also be changed in accordance with the order of the KPI and the decision of the department.

Work program for the academic discipline (syllabus): Compiled by:

Associate Professor of the Department of Mathematics and Physics, Candidate of Physical and Mathematical Sciences, Associate Professor O.O. Dykhovychnyi.

Approved by the Department of Mathematics and Physics (Minutes No. 13 of 11.06.2024).

Approved by the Methodological Council of the RTF (Minutes No. 6 of 28.06.2024).