



Mathematical analysis. Part 2.

Integral calculus

Syllabus

Requisites of the Course

Level of higher education	First (bachelor's)
Field of Study	12 Informational technologies
Specialty	121 Software Engineering
Educational program	Computer Systems Software Engineering
Status of the discipline	Normative
Form of study	full-time
Year of study, semester	1st year, autumn semester
Scope of the discipline	5 credits, 150 hours (36 hours lectures, 36 hours practical, 78 hours self-study)
Semester control/ control measures	Exam / modular control work, calculation and graphic work
Class schedule	http://rozklad.kpi.ua
Language of instruction	English
Information about the course instructors	<p>Lecturer: Associate professor, PhD, Iryna Ihorivna Golichenko, idubovetska@gmail.com Senior lecturer Iryna Petrivna Blazhievskaya, PhD, i.blazhievskaya@gmail.com</p> <p>Practical: Senior lecturer, Ph.D, Olena Oleksandrivna Vaneeva, vaneeva@gmail.com Associate Professor, Ph.D. N. Iryna Ihorivna Golichenko, idubovetska@gmail.com Assistant, Skorobagach Aunty Bohdanivna, tetianaskorobohach@gmail.com</p>
Placement of the course	https://campus.kpi.ua

Outline of the Course

1. Description educational disciplines, her goal, subject learning and the results teaching

Description disciplines	<p>In accordance to educational plan educational discipline "Mathematical analysis. Part 2" (GM 10.2) belongs to the cycle mathematical, natural and scientific preparation and has dominant value in the training of a specialist. It is necessary for successful assimilation of special disciplines. This credit card the module is based on students' knowledge acquired during study school mathematics course (algebra and geometry), educational disciplines "Mathematical analysis. Part 1" (GM 10.1). Discipline "Mathematical analysis. Part 2" is one with fundamental general education discipline what make up theoretical basis preparation engineers and programmers Knowledge and skills acquired by the student during the study of the data educational discipline, are used in the future at studies many the following discipline professional training of a specialist with a basic and complete higher education. At passing given disciplines students get acquainted from integration functions one variable; integration functions many variables. Series are studied - numerical, functional, exponent, trigonometric.</p>
Objectives disciplines	<p>the purpose educational disciplines is:</p> <ul style="list-style-type: none"> - formation of logical thinking in students, development their intelligence and abilities; - formation abilities to necessary intuition and erudition in questions application mathematicians, education in students applied mathematical culture; - formation of abilities to independently use and study literature with mathematicians, develop flexibility thinking, creative independence and action
Educational subject disciplines	<p>General mathematical properties and regularities. The main ones models and concepts of mathematical analysis, analysis and methods solution</p>
Competences	<p>Ability to abstract thinking, analysis and synthesis (GC01); Ability to apply knowledge in practical situations (GC02); Ability to search, processing and analysis information with different sources (GC06).</p>
Program results teaching	<p>Know and apply relevant mathematical concepts and methods blast furnace, systemic and object-oriented analysis and mathematical modeling for developments software software (PLO5)</p> <p>Know foundations integral calculus functions one variable (indefinite integral, primitive, basic methods of integration. Integration rational fractions, integration trigonometric verbal expressions; the definite integral, its geometric meaning, application defined integral, not their own integrals).</p> <p>To know the basics of integral calculus of functions of many variables (problems leading to the concept of double and triple integrals rules, definition, conditions of existence, properties, calculations in different systems coordinates, application to solution applied problems; problems that lead to the concept of curves- them integrals the first and the second kind, definition conditions existence, properties, application to the solution of applied tasks).</p>

	<p>To know the basics of the theory of series (the definition of a numerical series and its properties, signs convergence positive ones rows, absolute and conditional convergence for sign-changing series; definition of functional series, area of convergence; power series, their properties those; number Taylor , ranks Taylor for basic elementary functions, application to loved ones calculations).</p> <p>Know foundations theories harmonious analysis (trigonometric Fourier series, basic definitions, conditions of function expansion in number Fourier, examples applications).</p> <p>Be able to find original, have the main ones methods integration, calculate the definite integral, apply determined integral at solving applied tasks</p> <p>Be able to calculate double and triple integrals in different systems coordinates; curvilinear integrals, to solve applied tasks</p> <p>Be able to explore numerical and functional ranks on convergence, decompose functions in a row Taylor and Fourier series.</p>
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2. Prerequisites and post-requisites of the discipline (place in the structural and logical schemeteaching by corresponding educational program)

Prerequisites : A general course in mathematical analysis is the foundation of mathematics and engineering specialist education. It is necessary for successful learning of special disciplines. Educational discipline "Mathematical analysis. Part 2" is being studied in to the second semester and is based on knowledge obtained during the study of a school course in mathematics (algebra and geometry), educational discipline "Mathematical analysis. Part 1", "Linear algebra and analytic geometry".

Post-requisites : Credit module "Mathematical analysis. Part 2" precedes study disciplines "Probability theory" (GM 12).

3. Content educational disciplines

Name sections and topics	Number hours			
	In total	in ago number of		
		Lectures	Practical	Self-study
1	2	3	4	5
Section 1. <i>Integral calculus functions one variable</i> .				
<i>Topic 1.1. Unspecified integral. The main ones methods integration</i>	8	2	4	2
<i>Topic 1.2. Integration some classes functions.</i>	14	6	4	4
<i>Topic 1.3. Determined integral and him application.</i>	10	4	4	2
<i>Topic 1.4. Not their own integrals</i>	6	2	2	2
<i>Modular control work 1</i>	4	-	2	2
Section 2. <i>Integral calculus functions many variables</i> .				
<i>Topic 2.1. Multiples integrals</i>	16	6	4	6
<i>Topic 2.2. Curvilinear integrals</i>	10	4	2	4
<i>Modular control work 2</i>	4	-	2	2
Section 3. <i>Rows</i> .				

<i>Topic 3.1. Numerical ranks</i>	14	6	4	4
<i>Topic 3.2. Functional ranks</i>	6	2	2	2
<i>Topic 3.3. Degrees ranks</i>	8	2	2	4
<i>Topic 3.4. Trigonometric ranks</i>	6	2	2	2
<i>Modular control work 3</i>	4	-	2	2
<i>Typical calculation work</i>	10	-	-	10
Exam	30	-	-	30
In total hours	150	36	36	78

4. Educational materials and resources

Basic literature

1. Math in technical university: Textbook./ I.V. Alekseeva , V.O. Heidei ,O.O. Dykhovychyny , L.B. Fedorova; under the editorship O.I. Klesova ; KPI named after Igor Sikorsky, - Kyiv: KPI named after Igor Sikorskyi, 2021. - Volume 3. - 456 p.
<https://ela.kpi.ua/handle/123456789/39003>
2. Rows Functions complex variable Operational calculus. Compendium lectures (II course AND semester) / IN. AT. Heidei , L. B. Fedorova, AND. IN. Alekseeva , AT. AT. Dykhovychny . — To: NTUU "KPI", 2013. — 108 p.
<http://matan.kpi.ua/public/files/Konspekt%20Riady.%20FKZ.%20Operacijne%20chyslenia.pdf>
3. Math in technical university: Textbook./ I.V. Alekseeva , V.O. Heidei ,O.O. Dykhovychyny , L.B. Fedorova; under the editorship O.I. Klesova ; KPI named after Igor Sikorsky, - Kyiv: KPI named after Igor Sikorskyi, 2018. – Volume 1. - 496 p.
<http://ela.kpi.ua/handle/123456789/24338>
4. Rows Theory of functions of a complex variable. Operational calculation. Practicum (II year I semester) / Composer: V. O. Gaidei , L. B. Fedorova, I. V. Alekseeva , O. O. Dykhovychyny . – K.: NTUU "KPI", 2013. - 160 p.
<https://matan.kpi.ua/public/files/PraktykumRiady.pdf>
5. Mathematics in a modern technical university. Practicum Part 2. Differential and integral calculus functions one variable [Electronic resource] : educational a guide for students of higher educational institutions / I. V. Alekseeva , V. O. Gaidei , O. O. Spiritual [and etc.]. – Electronic textual data (1 file: 3.67 Mbyte). – Kyiv : NTUU "KPI", 2015. – 249 p.
<https://ela.kpi.ua/handle/123456789/16620>
6. Differential and integral calculus of functions of several variables. Differential equations. Workshop for students of technical specialties. / Compilers: Alekseeva I.V., Gaidei V.O., Spiritual O.O., Fedorova LB, - Kyiv: KPI named after Igor Sikorsky, 2016.- 188 page
<http://matan.kpi.ua/public/files/2016/%D0%9F%D1%80%D0%B0%D0%BA%D1%82%D0%B8%D0%BA%D1%83%D0%BC%D0%92%D0%9C2-2016.pdf>

Additional literature

7. Rows Theory of functions of a complex variable. Operational calculus: Collection of tasks to typical calculation work for students . 2nd year of technical faculties / Composition. S. V. Horlenko , L. B. Fedorova, V. O. Gaidei . – K.: Publishing House of IVC "Polytechnic", 2003. - 36 p.

8. Differential and integral calculus functions one variable Collection tasks to typical calculation work for first-year students of technical faculties. / Composer: L. B. Fedorova, N. R. Konovalova, AND. V. Alekseeva and others — K.: IVC "Polytechnic", 2001.
9. Dubovyk IN. P. Higher math / IN. P. Dubovyk, AND. AND. Yurik — Kyiv: Ignatex-Ukraine ,2013. — 648 p
10. Mathematics at a technical university: Workshop: In 4 hours / I. V. Alekseeva , V. O. Heidei , AT. AT. Dykhovychny , L. B. Fedorova. — Kyiv : NTUU "KPI", 2014. — 752 with.
11. school E., wheelwright T.V. Higher math. Book 1.- K.: Libid, 1994.
12. school E., wheelwright T.V. Higher math. Book 2.- K.: Libid, 1994.
13. school E., wheelwright T.V. Higher math. Book 3.- K.: Lybid, 1994.
14. Zill DG Advanced engineering mathematics / DG Zill , WS Wright . — Burlington : Jonesand Bartlett Learning , 2017. — 1004 pp .
15. Zill D. G. Calculus : Early transcendentas / D. G. Zill , W. S. Wright . — Sudbury : Jones andBartlett publishers , 2011. — 994 pp .

Informational resource

16. Math in technical university [Electronic resource] : textbook / AND. IN. Alekseeva , IN. AT. Heidei , AT. AT. Dykhovychny , L. B. Fedorova ; by ed. AT. AND. Klesova ; KPI named after Igor Sikorsky – Electronic textual data (1 file: 7.61 Mbyte). – Kyiv : Publishing House "Condor", 2019. - Vol. 2. - Regime access:
<https://ela.kpi.ua/handle/123456789/30396>
17. Mathematics in a modern technical university. Practicum Part 4. Rows. Theory functions of a complex variable. Operational calculus [Electronic resource]: educational a guide for students of higher educational institutions / I. V. Alekseeva , V. O. Gaidei , O. O. Dykhovychny [etc.] ; NTUU "KPI". – Electronic text data (1 file: 2.19 MB). – Kyiv : NTUU "KPI", 2015. - Mode access:
<https://ela.kpi.ua/handle/123456789/16627>

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

On-site/remote form

Lectures

No s/p	Name topics lectures and list basic questions (list didactic means, link on literature and task on Self-study)
1	Indefinite integral. Primitive function and indefinite integral: definition and their properties Table integrals. The main ones methods integration: direct integration, replacement method variable, integration in parts <i>Recommended literature:</i> [1], 9.1, 9.2.
2	Complex numbers _ Definition and geometric interpretation. Algebraic, trigonometric and indicative forms complex numbers actions over complex numbers. Euler's and Moivre's formulas . Elements of the theory of polynomials. Polynomials in complex and valid region Conditions identity two polynomials, roots of the polynomial. Theorem Lilac , main theorem algebra <i>Recommended literature:</i> [3], 3.4.
3	Integration rational functions. <i>Recommended literature:</i> [1], 9.3.
4	Integration of some classes of functions. Integration of expressions containing trigonometric functions. Universal trigonometric substitution. Integration some irrational expressions Differential binomial

	<i>Recommended literature:</i> [1], 9.4, 9.5.
5	The definite integral . Problems that lead to the concept of a definite integral. The integral is defined as the limit of integral sums. Necessary and sufficient conditions integrability functions on segment The main ones properties defined integral Determined integral with variable upper border integration and him properties Formula Newton-Leibnitz . Integration in parts replacement variablein definite integral. <i>Recommended literature:</i> [1] 9.6, 9.7.
6	Application defined integral Application defined integral in geometry and physics: calculating the areas of plane figures in Cartesian and polar figures coordinates; volumes bodies rotation, area surfaces rotation; length arcs curve in Cartesian and polar coordinates; calculation work variable strength <i>Recommended literature:</i> [1], 9.9.
7	Improper integrals. Improper integrals from bounded functions over unbounded ones interval: definition, convergence, divergence, main meaning. Improper integrals from unlimited functions on limited gap integration: definition convergence in understanding of the main meaning. <i>Recommended literature:</i> [1], 9.8.
8	Double integrals tasks, what bring to concept double integral Definition double integral and him properties Calculation double integrals. <i>Recommended literature:</i> [1], 10.1, 10.2.
9	Triple integrals Triple integral, him calculation in Cartesian coordinates The concept of n -fold integrals. Replacement of variables in multiple integrals.Cylindrical and spherical coordinates. <i>Recommended literature:</i> [1], 10.3.
10	Application multiples integrals . geometric, mechanical and physical application of multiple integrals: calculation of areas of flat figures, volumes of bodies, static moments and moments inertia flat and spatial figures finding coordinates centers mass material objects, calculation area surfaces <i>Recommended literature:</i> [1], 10.2, 10.3.
11	Curvilinear integrals the first genus Curvilinear integrals the first genus:problem, what brings to curvilinear integral the first kind, definition integral, its calculation and properties <i>Recommended literature:</i> [1], 10.4.
12	Curvilinear integrals the second genus Curvilinear integrals the second genus: the task of calculating the work of a force to move a material point along curve, definition of a curvilinear integral of the II kind, calculations, properties and connection with curve integrals of the first kind. Green's formula. Conditions of independence curvilinear integral from way integration Geometric and mechanical application curvilinear integrals. Application formulas Green <i>Recommended literature:</i> [1], 10.5.
13	Number series. Definition of series, partial sum, convergent and divergent series, remainder of the series. Operations on convergent numerical series. Convergence condition is necessary. Properties convergent numerical series. <i>Recommended literature:</i> [2], ch . 3.
14	Numerical ranks Rows with positive members Sufficient signs convergence numerical

	rows: comparison, Dalember , Cauchy, integral sign Koshi <i>Recommended literature:</i> [2], drug 1, 2.
15	Significance ranks Theorem Leibniz about convergence alternating signs rows, rating the remainder row Absolute and conditional convergence. <i>Recommended literature:</i> [2], medicine 3.
16	Functional ranks Region convergence Potochkova and uniform convergence functional rows Sign Weierstrasse uniform convergence Properties evenly convergent functional rows: theorems about continuity Sumy, member by member integration and member by member differentiation functional rows <i>Recommended literature:</i> [2], medicine 4.
17	Power series. Abel's theorem . Radius, interval and region of convergence of the power row Cauchy-Hadamard formulas . Properties of power series. Taylor series . enough nor the conditions for the expansion of the function into the Taylor series . Schedule of elementary functions in a series Taylor . <i>Recommended literature:</i> [2], medicine 5, 6.
18	Trigonometric series. Orthogonal and orthonormal systems of functions. Rows Fourier by orthogonal system functions. Trigonometric number Fourier. Dirichlet's theorem . Fourier trigonometric series for even and odd functions on $(-\pi, \pi)$, $(-l, l)$, for functions which set to arbitrary finite interval (a,b). <i>Recommended literature:</i> [2], lek. 7, 8.

Practical classes

No s/p	Name topics occupation and list basic questions (list didactic software, link on literature and task on Self-study)
1	Unspecified integral. The main ones methods integration <i>Task for Self-study:</i> [5], page 159-173.
2	Unspecified integral. The main ones methods integration <i>Task for Self-study:</i> [5], page 159-173.
3	Integration rational functions. <i>Task for Self-study:</i> [5], page 173-182.
4	Integration trigonometric functions. Integration some irrational functions. <i>Task for Self-study:</i> [5], page 182-191.
5	Determined integral. Formula Newton-Leibnitz . The main ones methods integration <i>Task for Self-study:</i> [6], page 73-80.
6	Application defined integral <i>Task for Self-study:</i> [6], page 81-87.
7	Not their own integrals <i>Task for Self-study:</i> [6], page 88-92.
8	Modular control work 1.
9	Multiples integrals <i>Task for Self-study:</i> [6], page 93-119.
10	Application multiples integrals. <i>Task for Self-study:</i> [6], page 105-119.
11	Curvilinear integrals <i>Task for Self-study:</i> [6], page 120-132.
12	Modular control work 2.
13	Numerical ranks Signs convergence positive ones rows <i>Task for Self-study:</i> [4], page 33-47.
14	Significance ranks

	<i>Task for Self-study:</i> [4], page 48-54.
15	Functional ranks <i>Task for Self-study:</i> [4], page 55-59.
16	Stepenev ranks <i>Task for Self-study:</i> [4], page 60-73.
17	Trigonometric series. <i>Task for Self-study:</i> [4], page 73-83.
18	Modular control work 3.

6. Self-study work

Study discipline includes the following types of self-study work:

- preparation to lectures and practical classes, implementation domestic tasks;
- implementation typical calculation works;
- implementation test tasks in remote courses on platform Moodle ;
- preparation and implementation modular control works;
- preparation to exam

Policy and CONTROL

7. Policy educational disciplines (educational component)

Recommended teaching methods: study of the main and auxiliary literature by topic lectures, solving tasks on practical classes and at performance domestic works

To a student is recommended lead detailed compendium lectures Important aspect quality assimilation material, working out methods and algorithms solution basic tasks disciplines are independent work. It involves mastering relevant literary sources, preparation to classes, implementation typical calculation work, preparation to MCW and exam

Academic virtue

Policy and principles academic integrity defined in section 3 of the Code honor National Technical University of Ukraine "Ihor Kyiv Polytechnic Institute Sikorsky". More details: <https://kpi.ua/code>

Norms ethical behavior

norms ethical behavior students and employees defined in section 2 of the Code honor National Technical University of Ukraine "Ihor Kyiv Polytechnic Institute Sikorsky". More details: <https://kpi.ua/code>

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

Distribution educational time by species classes and tasks with disciplines according to with working curriculum

Semester	Study _ time		Distribution educational hours			Control activities		
	Credits	Acad. hours	Lectur es	Practical	Self-study	MCW	CGW	Semester attestation
1	5	150	36	36	78	1	1	exam

Rating student with disciplines consists with points what he receives by

- 1) writing modular control works;
- 2) implementation estimated graphic work (CGW divided on few parts, according to topics)
- 3) answer on exams

Modular control work

Modular control work consists with three parts:

MCW -1 "Integral calculus of functions of one variable" - weight point 10

MCW -2 "Integral calculus of functions of many variables" - weight point 10

MCW -3 "Rows" - weight score 10

Maximum mark $10+10+10=30$.

Criterion assessment ICR : absence on control work – 0 points rating MCW is equal to size percent of it implementation.

At performance $< 60\%$ MCW not is counted

Calculated and graphical work

Gravimetric mark – 20.

Criterion assessment CGW:

Failure CGW – 0 points CGW is performed and is protected in parts what by content correspond to modular control work. Parts of the CGW are submitted before the writing of the MCW, a themselves MCW is protection

The CGW rating (in points) is equal to the value of the percentage (from the maximum number of points of 20) of it implementation with taking into account result writing corresponding MCW .

If less than 60% of the CGW is completed, it is not counted and must be completed. By untimely (later than on week) presentation CGW is counted not more 60% .

Answer on exams

Gravimetric mark – 50.

Gravimetric mark each task 10.

On exams student performs written examination work ticket consists with 1 theoretical question and 4 practical tasks

Criteria assessment

- "excellent": full answer on all task (not Less 90% necessary information; complete unmistakable solving tasks) 9 – 10 points;

- "good": enough full answer (not Less 75% necessary information) or is insignificant inaccuracies 7 – 8 points;

- "satisfactorily": incomplete answer on task (not Less 60%) and is errors and certain disadvantages 5 – 6 points;

- "fail": answer not responds conditions to "satisfactorily" (unsatisfactory answer, wrong solution method" 0 - 4 points

Maximum mark $10 \times 5 = 50$

Encouraging points are accrued

- by proper preparation for practical classes and active work on them;

- by prizes places on faculty and university Olympiads with higher mathematicians Maximum number encouraging points not exceeds 10% (5 points)

The size of the starting scale $R_C = 50$ points.

Size examination scales $R_E = 50$ points

Size scales rated $R = R_S + R_E = 100$ points

Conditions positive intermediate attestation

To receive "credited" from the first (8th week) and the second intermediate certification (14th week) a student must have at least 50% of the possible points at the time of the calendar exam control

Rearranging positive final semester attestation with purpose her increase not is allowed

Student is allowed to exam,

if his semester rating is not less than 30 points, at the same time he must have enrolled modular control works and CGW (not done Less, than on 60%).

students, which in the ends educational semester have start rating $R_c < 20$ points to are not allowed to take the exam and must liquidate arrears (complete the CGW, write the MCW) until the first rearrangement

Students with rating $20 \leq R_c < 30$ have possibility to get points to admissions , by implementation admission control work on to the last weeks educational semester

Table compliance rating points assessments by university scale:

Table 1

$R = R_c + R_e$	Traditional rating
$95 \leq R \leq 100$	Excellent
$85 \leq R \leq 94$	Very good
$75 \leq R \leq 84$	Good
$65 \leq R \leq 74$	Satisfactorily
$60 \leq R \leq 64$	Sufficient
$30 \leq R \leq 59$	Fail
$R_s < 30$ or not performed others conditions admission to exam	Not admitted

IN case remote forms teaching in RSO are happening the following changes:

- Control activities are held remotely from application electronic mail, Telegram ,Zoom and educational platform Moodle , in particular as test control works.
- The maximum weighted sum of x points of control measures during the semester *is* R_c is installed on levels 50 points
- admission mark to exam R_D is installed on levels 30 points
- Confirmation implementation a student requirements current control and conditions admission to exam must be displayed in Electronic campus _
- If the student does not receive the admission score, he is given the opportunity to raise it amount points R_I , typed a student for semester, by carrying out additional control measures to admission with appropriate reflection results in Electronic campus _
- Level acquisition provided for educational program competencies is defined on based on carried out measures current control, and also implementation a student conditions admission to exam respectively to approved by the RSO.
- The examination grade can be set "automatically" according to the formula by calculation starters points on a 100-point scale:

$$R = 60 + \frac{40(R_I - R_D)}{R_c - R_D}$$

Translated to examination evaluations according to with table 1.

9. Additional information with disciplines (educational component)

IN case remote forms teaching organization educational process is carried out with using e-mail, Telegram , video conferences in Zoom , an educational platform Moodle .
Current CONTROL may to be held in in the form test control works in Moodle . .

The working program of the academic discipline (syllabus):

Designed by Associate Professor of the Department of Mathematics Analysis and Probability Theory, PhD,
Iryna Ihorivna Golichenko

Adopted by the Department of MA and PT (protocol No. 16 dated 07/08/2022)

Approved by Methodical by the FMF council (protocol No 8 from 07/11/2022)