Higher Mathematics Part 2

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Шифр та назва спеціальності
133 – Industrial engineering
141 - Electric power engineering

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Інститут
IES in Mechanical Engineering and Transport
IES in Power Engineering, Electronics and
Electromechanics

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Освітня програма
Industrial engineering
Electric power engineering

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Кафедра
Applied Mathematics (170)

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Рівень освіти
Bachelor

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Тип дисципліни
General Education Course, mandatory

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Семестр
2

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Мова викладання
English

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Викладачі, розробники

Vyacheslav N. Burlayenko

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Candidate of Sci. in Engineering, Associate Professor, Head of the Department
of Applied Mathematics NTU "KhPI"

With 25 years of work experience, I have authored over 90 scientific and
educational-methodological works, including contributions to high-rank
international journals indexed in science metrics databases such as Scopus
and Web of Science. I have presented reports at distinguished international
conferences. My extensive teaching experience encompasses a diverse range
of mathematics courses, involving linear algebra, analytic geometry,
mathematical analysis, differential equations, series theory, and field theory.

More details on the web-page: https://web.kpi.kharkov.ua/apm/personal-ni-
storinki/burlayenko-v-yacheslav-mikolajovich/

Загальна інформація

Анотація

The "Higher Mathematics" course is tailored to form students' theoretical understanding and foster
practical skills in the application of mathematical concepts and mathematical methods of specific sections
of higher mathematics relevant to engineering disciplines. This course contributes to the development of
skills in analyzing and modeling various processes, utilizing information and communication technologies
when necessary.

Мета та цілі дисципліни

The purpose of this course is to equip students with the essential mathematical knowledge and skills
required for successful professional engagement in the fields of mechanical engineering and electrical

engineering. This knowledge serves as a crucial foundation for the subsequent study of disciplines incorporated into the training program within this field. The course fosters the development of logical thinking and the establishment of a solid mathematical groundwork, which is particularly vital for conducting research and solving applied problems.

Формат занять

Lectures, practical classes, individual independent work, consultations. The final control is an exam.

Компетентності

GC01. Ability to abstract thinking, analysis and synthesis.
GC02. Ability to apply knowledge in practical situations.
GC05. Ability to search, process and analyze information from various sources.
GC06 Ability to learn and master modern knowledge.
GC12. The ability to solve practical problems involving the methods of mathematics, physics and engineering.

Результати навчання

LR01. Proficiency in calculating the derivative function of a single variable, prerequisite to studying functions and graph plotting, integrating various classes of functions, computing definite integrals, and applying them to solve geometric problems, as well as determining partial derivative functions of multiple variables and investigating them for unconditional/conditional extrema. This mastery is crucial for utilizing mathematical tools and methods in the study of other mathematical courses and their application in the fields of industrial and electric power engineering.

Обсяг дисципліни

180 hours (6 ECTS credits): lectures – 32 hours, practical classes – 48 hours, individual independent work – 100 hours

Передумови вивчення дисципліни (пререквізити)

To successfully pass the course, you need to have knowledge and skills from the elementary mathematics course of high school and the topics of the first semester.

Особливості дисципліни, методи та технології навчання

The 'Higher Mathematics' course is delivered through a combination of lectures, practical classes, and consultations that incorporate multimedia technologies, in particualar, Microsoft Office 365 Teams. Additionally, students engage in individual independent study to master the educational material and complete individual educational tasks.

Програма навчальної дисципліни

Теми лекційних занять

Topic 1 – Derivative. Differentiation technique.
Definition of derivative, its mechanical and geometrical applications. Differentiation rules. Derivatives of basic elementary functions. Differential of function. Higher order derivatives and differentials. Approximate computations using differential.
Topic 2 – Applying derivative of function of single variable for investigating functions and plotting graphs.
Basic theorems of differential calculus: Rolle's, Cauchy's and Lagrange's theorems. L'Hospital's rule. Intervals of monotonicity, extrema. Necessary and sufficient conditions for extrema. Maximum and minimum of function on segment. Convexity and concavity of function graph, inflexion points. Necessary and sufficient conditions. Asymptotes of function graph. General scheme for investigation and plotting of functions.
Topic 3 – Antiderivative and Indefinite Integral.

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Notion of primitive and antiderivative. Basic properties of antiderivatives. Table of basic antiderivatives. Simplest integration techniques - direct integration through reduction to standard integrals, integration by parts, and substitution method. Integrating functions containing quadratic polynomial. Notion of rational fractions. Complex numbers and operations with them. Expansion of proper rational fractions in sum of simple fractions. Integrating rational fractions. Integrating trigonometric functions and functions containing irrationality.

Topic 4. – Definite integral and its applications
Definite integral. Classes of integrable functions. Properties of definite integral. Integral with variable lower and upper limit. Newton-Leibniz formula. Integrating by parts and change of variables for definite integral. Integrating even and uneven functions over symmetric interval. Polar coordinate system. Computing areas of plain regions. Length of curve segment. Parametric equation of curve. Computing length of curve segment. Volume of body of revolution. Improper integrals. Basic properties. Convergence tests.

Topic 5. Function of several variables.
Function of two variables. First order partial derivatives. Total differential of function of two variables. Higher order partial derivatives and differentials. Equation of surface tangent plane and normal. Extrema of function of two variables. Scalar field. Directional derivative. Gradient.

Теми практичних занять

According with lectures:
Topic 1 – Derivative. Differentiation technique
Differentiation technique. Differential of function. Higher order derivatives and differentials.
Topic 2 – Applying derivative of function of single variable for investigating functions and plotting graphs.
L'Hospital's rule. Studying function monotonicity. Extrema of function. Determining minimum and maximum of function on segment. Intervals of convexity and concavity of function graph, inflexion points. Determining function asymptotes. Investigating functions using derivatives and plotting their graphs.
Topic 3 – Antiderivative and Indefinite Integral.
Table of integrals. Simplest integration techniques. Invariability of integration formulae. Integration methods: direct integration through reduction to standard integrals, integration by parts, and substitution method. Integrating functions containing quadratic polynomials. Complex numbers and operations with them. Integrating rational fractions. Integrating trigonometric functions and functions containing irrationality.
Topic 4. Definite integral and its applications
Newton-Leibniz formula. Integrating by parts and change of variables for definite integral. Computing areas of plain regions. Computing length of curve segment. Volume of body of revolution. Studying convergence of first and second kind improper integrals.
Topic 5. Function of several variables.
Domain of functions of several variables. Techniques for computing first and second order partial derivatives of functions of several variables. Equation of surface tangent plane and normal. Extrema of function of two and more variables. Conditional extremum of function of two and more variables. Methods for solving problems on extremum.

Теми лабораторних робіт

Not provided

Самостійна робота

The course involves students' engagement with lecture materials, preparation for practical classes, completion of individual tasks, and readiness for tests. Supplementary materials for individual independent study on course topics are also provided to students. Throughout the semester, students are evaluated on their performance in individual home tasks (IHZ), which are composed of assignments aligned with the semester's themes, namely:
1. Revising lecture contents on limits and continuity of functions.
2. Investigating function using derivative and plotting thier graphs.
3. Integration of functions with quadratic irrationality in the denominator and a polynomial in the numerator, utilizing the Gauss-Ostrogradsky formula.

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1885

4. Computing area of plane region, length of plane curve segment, volume of body of revolution in polar coordinates.
5. Equations of surface tangent plane and normal using the gradient definition.
6. Lagrange method for finding conditional extremum of functions of several variables.

Література та навчальні матеріали

Basic references

1.
Higher mathematics. Problem solving and variants of typical calculations. Edited by Dr.Sci.Tech. Kurpa L.V. – Kharkiv: NTU "KhPI", 2004. – Volume 1.
2. Higher mathematics. Problem solving and variants of typical calculations. Edited by Dr.Sci.Tech. Kurpa L.V. – Kharkiv: NTU "KhPI", 2004. – Volume 2.
3. Kurpa L.V., Shmatko T.V. Differential and Integral Calculus for One Variable Functions: Textbook. – Kharkiv: NTU KhPI: 2017.-324 pages
4. L.V. Kurpa, T.V.Shmatko. Differential and integral calculus for functions with several variables: Textbook. – Kharkiv: NTU KhPI: 2012.

Additional references

5. Gerald B. Folland, Real Analysis: Modern Techniques and Their Applications (Pure and Applied Mathematics), New York, Academic Press, 1999
6. Mahmudov E. Single Variable Differential and Integral Calculus: Mathematical Analysis. Atlantis Press, Paris, France, 2013. - 369 pages
7. Lafferriere B., Lafferriere G., Mau Nam N. Introduction to Mathematical Analysis I. - 2nd Ed. PDXOpen Textbooks. 2016. - 166 pages.
8. Chidume O. C. Foundations of Mathematical Real Analysis: Computer Science Mathematical Analysis. 2019.

Система оцінювання

Критерії оцінювання успішності студента та розподіл балів

The final grade for the semester is determined by combining the points earned during the semester (80 points) and those obtained in the exam (20 points). The exam comprises a written assignment, which includes one theoretical question and two practical problem-solving questions, followed by an oral presentation.
The current evaluation, accounting for 80%, comprises three control works, three individual obligatory tasks, and two tests. During the intervals between modular knowledge assessments, students are engaged in independent work, as outlined in the educational program.

Шкала оцінювання

Сума балів	Національна оцінка	ECTS
90–100	Відмінно	A
82–89	Добре	B
75–81	Добре	C
64–74	Задовільно	D
60–63	Задовільно	E
35–59	Незадовільно (потрібне додаткове вивчення)	FX
1–34	Незадовільно (потрібне повторне вивчення)	F

Норми академічної етики і політика курсу

The student is required to adhere to the Code of Ethics for Academic Relations and Integrity of NTU 'KhPI,' demonstrating discipline, education, benevolence, honesty, and responsibility. Any conflict situations should be openly discussed within study groups with the teacher. If it proves impossible to resolve the conflict at this level, it should be brought to the attention of the institute's directorate employees.

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The regulatory and legal support for implementing the principles of academic integrity at NTU 'KhPI' is available on the website: http://blogs.kpi.kharkov.ua/v2/nv/akademichna-dobrochesnist/

Погодження

Syllabus approved by	Date of approval, signature	Head of the AM Department Vyacheslav BURLAYENKO
	Date of approval, signature	Garantee of EP for Industrial engineering Iryna TYNIANOVA
	Date of approval, signature	Garantee of EP for Electric power engineering Hanna OMELIANENKO

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