



Силабус освітнього компонента Програма навчальної дисципліни



Higher Mathematics Part 3

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

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

Освітня програма
Industrial engineering
Electric power engineering

Кафедра
Applied Mathematics (170)

Рівень освіти
Bachelor

Тип дисципліни
General Education Course, mandatory

Семестр
3

Мова викладання
English

Викладачі, розробники



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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-nistorinki/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 finding solutions of ordinary differential equations and system of ordinary differential equations of the first order, computing multiple integrals and curvilinear integrals, and applying them to solve geometric and mechanical problems. 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 and second semesters.

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 particular, 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 – Ordinary Differential Equations.

Problems leading to necessity of solving differential equations. The general and partial solution. Problem by Cauchy. Equations with separable variables. Homogeneous differential equations in Euler's sense. Linear differential equations and solving methods for linear equations of the first order. Bernoulli's equations. Exact differential equations (equations in total differentials). Equations not explicitly solved for derivatives. Differential equations of higher orders. General conceptions. Some types of the second order differential equations reducible to the first order equations.

Topic 2 – Elements of theory of Linear Differential Equations.

Linear differential equations of the second order. The general theorems. Wronskian's determinant. Ostrogradskiy-Liuvill's formula. Homogeneous linear equations of the second order with constant coefficients. The general theorems for nonhomogeneous linear equations of the second order. The linear differential equation of the second order with constant coefficients and special right part. The method of variation of an arbitrary constants. Homogeneous linear equations of the n-th order with constant

coefficients. Higher order inhomogeneous linear equations. Systems of Differential Equations. General Concept and Definition. Systems of Linear Differential Equations. Method of Elimination.

Topic 3. – Multiple integrals and their applications.

Double integral. Some problems leading to concept of the double integrals. Calculation of the double integrals in the Cartesian coordinate system. Curvilinear coordinates on the plane. Change of the variables in the double integrals. Physical applications of the double integral. Triple integral calculation and applications. Calculation of the triple integral in the Cartesian coordinates system, in cylindrical and spherical coordinate systems.

Topic 4. - Curvilinear and Surface Integrals and their applications.

Curvilinear integral of the first kind. Applications of the curvilinear integrals of the first kind. Curvilinear integrals of the II-nd kind (line integrals). Calculation, physical and geometrical properties. Connection between line integrals and curvilinear integrals of the first kind. Green's formula. Condition for line integral to be independent of the integration path. Finding function by its total differential. Surface integrals of the I-st and of the II-nd kind. Physical and geometric properties of these integrals. Surface integrals over a closed surface. Ostrogradsky-Gauss formula. Stokes' formula.

Теми практичних занять

According with lectures:

Topic 1 – Ordinary Differential Equations.

Finding solutions of the equations with separable variables. Integration of the homogeneous differential equations in Euler's sense. Finding solutions of the linear equations. Integration of the Bernoulli's Equations. Finding solutions of the exact differential equations (equations in total differentials). Different types of the differential equations. Finding solutions of high order differential equations reducible to lower order equations.

Topic 2 – Elements of theory of Linear Differential Equations.

Finding solutions of the homogeneous linear equations of the n-th order with constant coefficients. Finding solutions of the nonhomogeneous linear equations of the n-th order with constant coefficients and specific right parts. Finding solutions of the Systems of Differential Equations by reducing to high order linear differential equation.

Topic 3. - Multiple integrals and their applications.

Calculation of the double integrals in Cartesian system coordinates. Calculation of the solid volumes in Cartesian system coordinates. Calculation of double integrals in polar system of coordinates. Physical applications of the double integral. Calculation of the triple integrals in Cartesian system of coordinates, in cylindrical and spherical systems of coordinates.

Topic 4. - Curvilinear and Surface Integrals and their applications.

Curvilinear integral of the first kind: calculation and applications. Curvilinear integral of the II-nd kind: calculation and applications. Application of the Green's formula. Independence of the line integrals on form of the integration path. Finding antiderivative. Evaluation of the surface integrals of the I-st and of the II-nd kind. Evaluation of the surface integrals over a closed surface. Ostrogradsky-Gauss formula. Stokes' formula.

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 differential and integral calculus of single variable functions.
2. Equations reducing to homogeneous differential equations. Equations by Lagrange and Clairaut.
3. Finding solutions of the Systems of Differential Equations by using matrix exponential method.
4. Using multiple integrals for mechanical and engineering applications.
5. Using curvilinear and surface integrals for physical and engineering applications.

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 2.
2. Higher mathematics. Problem solving and variants of typical calculations. Edited by Dr.Sci.Tech. Kurpa L.V. – Kharkiv: NTU “KhPI”, 2004. – Volume 3.
3. L.V. Kurpa, T.V.Shmatko. Differential and integral calculus for functions with several variables: Textbook. – Kharkiv: NTU KhPI: 2012.

Additional references

4. Zill D.G. A first course in differential equations. 9th Ed. Brooks/Cole Cengage Learning. Belmont. CA. 2009.
5. Andriychuk M. Matrix Theory - Classics and Advances. IntechOpen, Rijeka. 2023. - 272 pages. <https://doi.org/10.5772/intechopen.97927>
6. Wrede R., Spiegel M. Schaum's Outline of Advanced Calculus, 3rd Ed. McGraw-Hill Companies, Inc. 2010.
8. Deolinda M.L. Dias Rasteiro, Manuel Rodríguez-Martín, Pablo Rodríguez-Gonzálvez. Chapter 7 - Multiple integrals in mechanical engineering. In: Mathematics in Science and Engineering, Calculus for Engineering Students. Academic Press. 2020. PP. 137-156.
9. Kreyzig E. Advanced Engineering Mathematics. John Wiley & Sons, Inc. 10th Ed. 2011.
10. Sherman G.C. An introduction to integration over curves and surfaces for students of electricity and magnetism. 2009. -141 pages

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.

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 TYNIAKOVA

Date of approval, signature

Garantee of EP for Electric
power engineering
Hanna OMELIANENKO

