

Tadeusz Kosciuszko Cracow University of Technology

Course Card

Faculty of Civil Engineering

Field of study: Civil Engineering

Study profile: general academic

Study form: full-time

Field of study code: BUD

Study cycle: 1st

Specialty: no specialty

1 COURSE INFORMATION

| | |
|------------------------|-----------------------|
| Course name | Matematyka |
| Course name in English | Mathematics |
| Course code | WIL BUD oIS B10 24/25 |
| Course category | Przedmioty podstawowe |
| No. of ECTS points | 12.00 |
| Semester | 1 and 2 |

2 CLASS TYPE, NUMBER OF HOURS ACCORDING TO THE STUDY PLAN

| Semester | Lecture | Class exercise | Laboratory | Computer lab | Design exercise | Seminar |
|----------|---------|----------------|------------|--------------|-----------------|---------|
| 1 | 45 | 30 | 0 | 0 | 0 | 0 |
| 2 | 30 | 30 | 0 | 0 | 0 | 0 |

3 COURSE OBJECTIVES

Objective 1 Introduction to mathematical analysis.

Objective 2 Introduction to linear algebra with geometry.

Objective 3 Introduction to the ordinary differential equations.

4 PREREQUISITES IN TERMS OF KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1 Knowledge of the topics from the field of high school mathematics

5 LEARNING OUTCOMES

L01 Knowledge of definitions, theorems and methods of mathematical analysis

L02 Solving mathematical analysis tasks

L03 Knowledge of definitions, theorems and methods of linear algebra

L04 Solving linear algebra tasks

L05 Knowledge of definitions, theorems and methods in the area of differential equations

L06 Solving ordinary differential equations

6 COURSE CONTENT

| Lecture | | |
|---------|--|--------------------|
| No. | Subject matter of the course Detailed description of thematic blocks | No. of class hours |
| L1 | Infinite sequences and their limits, basic examples, the sandwich theorem for sequences, the nondecreasing sequence theorem. | 3 |
| L2 | Functions of one real variable. Limits and continuity, inverse functions, composite functions, basic results on continuous functions, the definition of the derivative and interpretation, rules of differentiation, including chain rule, higher derivatives. Rolles theorem, the mean value theorem, Taylors theorem, l'Hopitals rule, extreme values of functions, monotonic functions, asymptotes, sketching graphs. | 9 |
| L3 | Indefinite integrals. The definition of the indefinite integral, basic integration formulas. Methods of integration: substitution, by parts, integration of rational functions by partial fractions, trigonometric integrals. | 6 |
| L4 | Matrices and determinants, systems of linear equations. The definition of a matrix, matrix operations. Determinants, basic properties, inverse matrices, singular matrices, simultaneous linear equations, Cramer's rule, the Kronecker-Capelli theorem. | 6 |
| L5 | Elements of analytic geometry. Vector operations (addition, scalar product, dot product, cross product). Straight lines and planes in the 3-dimensional Euclidean space. | 6 |
| L6 | Linear algebra. Vector spaces, linear independence of vectors, basis and dimension of a vector space, coordinate vectors, changing bases in vector spaces, linear transformations and their matrices, eigenvalues and eigenvectors, orthonormal bases, Einstein summation convention, Cartesian tensors, operations on tensors. | 9 |

| Lecture | | |
|------------|--|--------------------|
| No. | Subject matter of the course Detailed description of thematic blocks | No. of class hours |
| L7 | Definite integrals. The definition of the definite integral, basic properties, the Fundamental Theorem of Calculus, applications of definite integrals, improper integrals. | 6 |
| L8 | Complex numbers. Arithmetic operations with complex numbers, the modulus-argument form of a complex number, powers and roots. | 3 |
| L9 | Functions of several variables. Limits and continuity, partial derivatives, directional derivatives, the total differential, the chain rule. Applications of partial derivatives. Higher-order partial derivatives, Taylor's theorem, local extreme values. Definite integrals. The definition of the definite integral, basic properties, the Fundamental Theorem of Calculus, applications of definite integrals, improper integrals. | 6 |
| L10 | Double and triple integrals. The definition of the double and triple integrals, iterated integrals, Fubini's theorem, curvilinear coordinates, Jacobi's theorem. | 6 |
| L11 | Line and surface integrals. The definition of the line integral of the first kind, basic properties and applications. The area of a surface, the definition of the surface integrals of the first kind, its applications. Line and surface integrals of the second kind. The definition of the line integral of the second kind, its physical meaning, the path independence principle, Greens theorem. The definition of the surface integrals of the second kind, Gauss's theorem. | 9 |
| L12 | Ordinary differential equations. First-order differential equations, particular and general solutions, the existence and uniqueness theorem, separation of variables, exact equations, linear equations. Second-order linear equations with constant coefficients, the characteristic equation, variation of parameters, undetermined coefficients, systems of linear differential equations. | 6 |

| Class exercise | | |
|----------------|---|--------------------|
| No. | Subject matter of the course Detailed description of thematic blocks | No. of class hours |
| C1 | Finding limits of sequences using theorems introduced in the lectures. | 2 |
| C2 | Functions of one real variable, their domains and other properties, finding function limits and examination of continuity, practice in differentiation, using l'Hopital's rule to find limits, function examination, optimization problems. | 6 |
| C3 | Indefinite integrals. Integration practice using the techniques introduced in the lectures. | 4 |
| C4 | Operations on matrices, calculating determinants, solving systems of linear equations. | 4 |
| C5 | Vector operations, dot and cross products and their applications, lines in space, equations of a plane, distances and symmetry of space objects: points, lines and planes. | 4 |

| Class exercise | | |
|----------------|---|--------------------|
| No. | Subject matter of the course Detailed description of thematic blocks | No. of class hours |
| C6 | Linear algebra: identifying vector spaces and subspaces, linear independence of vectors, calculating coordinates of vectors in different bases, evaluating the matrix of a linear transformation in different bases, finding eigenvalues and eigenvectors, practice in operations on Cartesian tensors. | 6 |
| C7 | Evaluating definite integrals, applications to computing the areas of domains, the arc length, the volume of a solid of revolution, examples of improper integrals. | 4 |
| C8 | Complex numbers: practice following the concepts introduced in the lectures. | 3 |
| C9 | Functions of two and three variables: limits, continuity, practice in partial and directional differentiation, finding local extreme values. | 6 |
| C10 | Evaluating double integrals over rectangles and nonrectangular regions, computing triple integrals, geometrical and physical applications of multiple integrals. | 6 |
| C11 | Evaluating line and surface integrals, computing the total mass of a weighted curve, the work done by a vector field along a path, conservative vector fields, applications of Gauss' theorem. | 9 |
| C12 | Solving differential equations of various types, initial-value problems, solving systems of linear differential equations. | 6 |

7 TEACHING TOOLS

N1 Lectures

N2 Blackboard tasks

N3 Consultation

N4 Multimedia presentation

8 Student workload

| Activity form | Number of hours of activity |
|--|-----------------------------|
| Hours realized in contact with the teacher | |
| Hours resulting from the study plan | 135 |
| Consultation hours | 45 |
| Exams and tests during session | 20 |
| Hours of autonomous student work | |
| Preparing for classes, studying literature | 160 |
| Developing results | 0 |
| Preparing of reports, projects presentations, discussion | 0 |
| Total number of hours devoted to the subject | 360 |
| Total number of ECTS points | 12.00 |

9 Methods of grading

Partial grades

F1 Colloquium

Summary grade

P1 Written exam

P2 Weighted average of the midterm tests grades

P3 Exam oral
