Mathematical analysis I - course description

General information

Course name	Mathematical analysis I
Course ID	11.1-WF-FizP-MA-I- 17
Faculty	Faculty of Physics and Astronomy
Field of study	Physics
Education profile	academic
Level of studies	First-cycle studies leading to Bachelor's degree
Beginning semester	winter term 2022/2023

Course information

Semester	1
ECTS credits to win	8
Course type	obligatory
Teaching language	english
Author of syllabus	• prof. dr hab. Andrzej Maciejewski

Classes forms

The class form	Hours per semester (full-time)	Hours per week (full-time)	Hours per semester (part-time)	Hours per week (part-time)	Form of assignment
Lecture	60	4	-	-	Exam
Class	60	4	-	-	Credit with grade

Aim of the course

Familiarize students with the basic concepts, theorems and methods used in the differential and integral calculus and their application in dealing with selected physical problems.

Prerequisites

Knowledge of mathematics at the secondary school level.

Scope

Lecture

I. Functions of one variable.

1. Concept of function. Elementary functions: polynomials, rational functions, trigonometric functions, exponents and logarithms, and their properties. The composite and the inverse function.
2. Inverse trigonometric functions. Elementary transformations of function graphs.

II. The limit of number sequences and functions.

1. The definition of a number sequence. Monotonicity and boundedness of sequences and functions.
2. Convergence of sequences. Theorems on limits of sequences. The so called sandwich rule in convergence checking.
3. Limits and continuity of functions. Properties of continuous functions.

III. Series of numbers

1. The concept of the sum of infinite series. The criteria for convergence of the series.

IV. Differential calculus of functions of one variable

1. The definition of a derivative, geometric and physical interpretation, the basic rules of differential calculus.
2. Differential of function. Differentiability of functions.
3. The mean value theorems and their applications.
4. De L'Hospital rule and its application in the limits of functions.
5. Taylor and Maclaurin formula.
6. The monotonicity of function. Local and global extremes.
7.

Convex and concave functions. Inflection points of the graph.

8. Examination of a function.
9. Physical applications of differential calculus.

V. Integral calculus of functions of one variable

1. Antiderivative. The property of indefinite integrals. The rules of integration.
2. Methods for calculating indefinite integrals - integration by parts, integration by substitution, integration of rational functions, integration of trigonometric and irrational function.
3. Definite integral and its properties.
4. The applications of integral calculus in geometry and physics.
5. Improper integrals.

VI. Differential equations.

1. Differential equations with separated variables.
2. Homogeneous equations. Inhomogeneous equation.
3. Linear equations of the first and the second order. Bernoulli's equations.
4. Applications of differential equations.

VII. Vector function of one variable.

1. The definition of vector function of one variable.
2. Calculating the derivatives of vector functions (material should be accomplished by the student her or him-self on the basis specified by the lecturer)

Exercises

I. Functions of one variable

1. Determining the domain and the range of the function. Checking the properties of the function. Determining the composite and the inverse functions.
2. Constructing and transforming graphs of functions.

II. The limit of number sequences and functions.

1. Testing properties of sequences.
2. Calculation of limits of sequences and functions.
3. Checking the properties of continuous functions.

III. Series of numbers

1. Checking the necessary condition of convergence of the series. Studying the convergence of the series.

IV. Differential calculus of functions of one variable

1. Calculating the derivative.
2. The use of de L'Hospital rule to calculate limits of functions.
3. Development of functions in Taylor and Maclaurin series.
4. Studying the monotonicity of functions. Determination of local and global extremes of functions.
5. Determination of inflection points and concavity and convexity intervals.
6. Examination of a function.
7. The usefulness of calculus in dealing with physical problems.

V. Integral calculus of functions of one variable

1.

Integration of functions by the methods from the lecture.

2. Calculation of definite integrals and its applications in geometry and physics
3. Studying convergence of improper integrals.

VI. Differential equations

1. Solving differential equations with separated variables.
2. Solving homogeneous and inhomogeneous equations.
3. Solving linear equations of I and II-order and the Bernoulli equations.
4. The application of differential equations to physical problems.

Teaching methods

Conventional lectures, exercises auditorium, group work, problem-classical method, the discussion, the use of multimedia.

Learning outcomes and methods of theirs verification

Outcome description	Outcome symbols	Methods of verification	The class form
1. After completing the course a student has acquired knowledge of the following topics: - the concept of a limit of a sequence, series and a function, - the concepts of derivative and differential of function, L'Hospital's rule, monotonicity, extreme values and concavity intervals of a function, sketching graph of a function, optimization problems arising in different branches of science, - the basic concepts and theorems of integral calculus, the method of integration by parts and by substitution, application of the definite integral to appropriate physical problems, - basics in differential equations. 2. The student selects appropriate methods of calculus to cope with a problem. 3. He or she is aware of his or her knowledge and skills and understands the need for continuous training and improvement of his or her skills.	• K1A_W02 • K1A_W03 • K1A_U01 • K1A_U02 • K1A_K01	• a discussion • an exam - oral, descriptive, test and other	• Lecture
1. After completing the course a student has gained the ability to: - determine the limit of sequences and functions, to examine the convergence of series, - calculate derivatives and using them in the study of monotonicity, extremes and the concavity intervals of a function, the student can make pictures of progress of a function and can solve selected optimization problems arising in different branches of science, - the student is able to calculate the several types of indefinite integrals, he or she uses the method of integration by parts and by substitution and can apply integral calculus to the appropriate physical problems, - the or she can solve basic types of differential equations and can describe physical phenomena in terms of differential equations. 2. The student make use of variety of materials available in Polish as well as English resources to interpret, analyze and correctly infer on their base. 3. The student is able to present and confront his opinion and persuasion during discussion, analyzing and solving scientific problems in the classroom.	• K1A_W02 • K1A_W03 • K1A_U01 • K1A_U02	• a discussion • an evaluation test • an observation and evaluation of activities during the classes	• Class

Assignment conditions

Class:

The grade consists of two criteria: the scores in four tests organized during classes (80%) and degree of active participation in classes and suitable preparation (20%). A student is required to obtain at least 50% of maximal score. The student with the lowest passing grade of 10% of maximal score may write a correction test before the exam class.

Lecture:

The final exam is composed of written part and conversation; to be admitted to the second part a student must receive at least 30% of maximal score of the first part. To be admitted to the exam a student must receive a credit for the class.

The course credit consists of the class grade (50%) and the exam grade (50%). The course credit is attained by positive passing both class and exam.

Recommended reading

[1] R. Rudnicki, W*ykłady z analizy matematycznej*, PWN, Warszawa 2006.

[2] Sołtysiak, *Analiza matematyczna, Część I,* (Wykłady z matematyki dla studentów fizyki), Wydawnictwo Naukowe UAM, Poznań 1995.

[3] M. Gewert, Z. Skoczylas, *Analiza matematyczna 1, Definicje, twierdzenia, wzory*, Oficyna Wydawnicza GIS, Wrocław 2005.

[4] M. Gewert, Z. Skoczylas, *Analiza matematyczna 1, Przykłady i zadania*, Oficyna GIS, Wrocław 2005.

[5] Ron Larson, Bruce H. Edwards, *Calculus, 9th Edition,* Cengage Learning 2010.

[6] W. Krysicki, L. Włodarski, *Analiza matematyczna w zadaniach,* cz. 1 i 2, PWN, Warszawa 1992.

Further reading

[1] J. Banaś, S. Wędrychowicz, *Zbiór zadań z analizy matematycznej*, WNT, Warszawa 1994.

[2] G. M. Fichtenholz, *Rachunek różniczkowy i całkowy*, tom I i II, PWN, Warszawa 1995.

[3] F. Leja: *Rachunek różniczkowy i całkowy*, PWN, Warszawa 1972.

[4] R. Adams, C. Essex, *Calculus - A Complete Course 7th ed* - (Pearson Canada, 2010) BBS.

[5] G. I. Zaporożec, *Metody rozwiązywania zadań z analizy matematycznej*, WNT, Warszawa 1976.

[6] Earl W. Swokowski, *Calculus with Analytic Geometry,* Alternate Edition –PWS Publisher 1983.

Notes

Modified by dr Marcin Kośmider (last modification: 11-05-2022 20:37)