Mathematics

Prof. Elena Bianco

***Text under revision. Not yet approved by academic staff.***

COURSE AIMS AND INTENDED LEARNING OUTCOMES

At the knowledge and competences level, the course aims to provide students with an adequate theoretical understanding of the fundamental elements of mathematical analysis, as well as a good ability to perform the calculations and procedures required in carrying out exercises and problems, necessary skills for an effective application of mathematics in the courses that characterise the study plan.  
Another important objective of the course is to help students acquire a good command of the logical-mathematical language as a model of rigorous communication of scientific contents.  
In summary, at the end of the course, students will be able to:  
1) Know the meaning and interpretation of the mathematical tools covered by the course. For example, know the meaning of a derivative and how to interpret it as a growth rate or angular coefficient of the tangent line on a graph.  
2) Perform calculations according to the rules set out in the course. For example, be able to apply the rules for calculating derivation and integration.  
3) Apply the methods for studying graphs of functions and interpreting them. For example, apply derivatives to determine the maxima and minima of a function.  
4) Communicate the statement of a theorem in a formally correct language.

COURSE CONTENT

The course covers the basic concepts and methods of mathematical analysis: calculus of limits, differential and integral calculus for real functions of a real variable.  
Although the presentation of the subject matter favours an understanding of the concepts and calculation techniques over formal rigour, some theorems chosen with relative proof constitute an integral part of the course.

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|  | ECTS |
| Teaching chapter: Real Functions of a Real Variable | 1.0 |
| General features of the real functions of a real variable.  Elementary functions and geometric transformations. Piecewise functions.  Relative and absolute extrema of a function.  Analysis of the graph of a function. |  |
| Teaching chapter: The Limits of Real Functions of a Real Variable and Continuity | 1.0 |
| The definition of a limit.  Continuous functions. Theorems of continuous functions in closed and limited intervals.  Rules for calculating limits. Indeterminate forms. Notable limits.  Probable graph of a function. |  |
| Teaching chapter: Differential Calculus | 2.0 |
| Derivability and the derivative of real functions of a real variable. Geometrical meaning of derivative.  Derivatives of elementary functions. Rules of derivation. Derivatives of composite functions.  Differential calculus theorems. Taylor's formula.  Monotonicity and concavity of a function. Relative and inflected extrema. Studying functions.  Average and instantaneous rate of change. |  |
| Teaching chapter: Integral Calculus | 2.0 |
| Theory of integration according to Riemann. Fundamental properties of the definite integral.  The integral mean value theorem.  Primitives. The integral function. The fundamental theorem of integral calculus. Fundamental formula of integral calculus.  Primitives of a function. Indefinite integral. Integration rules. Calculation of definite integrals. Calculation of areas.  First order differential equations. Applications. |  |
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READING LIST

* S. Annaritone, *Matematica sul campo. Tecniche ed esempi applicativi alle scienze della vita con Mylab e eText,*Pearson (ISBN 9788891901422). Textbook.
* AM Bigatti-l. Robbiano, *Matematica di base. Second edition,* Casa Editrice Ambrosiana.
* Benedetto, Degli Esposti, Mattei, *Dalle funzioni ai modelli, il calcolo per le bioscienze,* Casa Editrice Ambrosiana.
* P. Baiti-L. Freddi, *Corso integrato di Matematica per le scienze naturali ed applicate,* Forum Ed., 2015.
* RA Adams,*Calcolo Differenziale 1 - Fifth Italian edition,* Casa Editrice Ambrosiana.

TEACHING METHOD

1) Theoretical frontal and dialogue-based lectures in which the concepts, calculation rules and methods of solving exercises and problems are presented. The theoretical discussion is always accompanied by application examples.   
2) Frontal practical activities, during which exercises and problems are solved using the methods seen in class.  
3) Practical activities proposed for individual study (homework) which will then be discussed in class. In these activities, active participation by students in the undertaking of the work is required.

The lectures and practical activities held, as well as other teaching material, will be available to students on the special E-learning Blackboard platform prepared by Università Cattolica.

ASSESSMENT METHOD AND CRITERIA

There will be both a written and an oral exam. The written exam is aimed at ascertaining the student's calculation skills and ability to apply the methods. The oral exam is aimed at ascertaining the student's theoretical competence.

During the course, two optional interim tests are envisaged, which, if passed, replace the written exam. The first interim test focuses on the first two/three chapters and comprises 6-7 exercises, with a maximum mark of 30/30 and a duration of 3 hours. The second interim test covers the third/fourth chapter and comprises 5-6 exercises, with a maximum mark of 30/30 and a duration of 3 hours. Each test is considered passed if a minimum mark of 15/30 is achieved. A supplementary test will be possible for those who fail or are absent for an interim test, and a cumulative supplementary test will be possible at the end of the course for those who fail or are absent for both interim tests. These supplementary tests are structured and assessed in the same way as the interim tests. The cumulative supplementary test consists of exercises drawn from the four chapters. The average of the marks achieved for the two tests passed represents the mark for the written exam.

If a student does not take the interim tests or fails to pass them, a written exam is envisaged for the official exam period, which covers all the chapters of the course. It consists of 5 exercises, with a maximum mark of 30/30 and a duration of 2 hours. The exam is considered passed if a minimum mark of 15/30 is achieved.

The oral exam may be taken if the written exam has been passed. The oral exam consists of 3 questions of a theoretical nature covering all of the course chapters and adds a further mark between -3 and +3 to the written exam mark.

NOTES AND PREREQUISITES

The language of mathematics: connectives, quantifiers. Set theory. Numerical sets: integers, rational numbers, real numbers. Axioms of real numbers. Algebra. First and second degree algebraic equations and inequalities of integers and fractions. Binomial equations and inequalities, equations and inequalities with modulus and irrationals (elementary cases). Exponentials and logarithms. Exponential and logarithmic equations and inequalities. Elementary notions of analytical geometry (Cartesian plane, straight lines). First notions of trigonometry.

NOTES AND PREREQUISITES

The course comes with:

* 8 pre-course hours, during which the prerequisite contents are covered.;
* 20 hours of support, during which the exercises carried out individually by students are corrected, or further exercises are carried out in order to pass the interim tests.

Should the health situation relating to the Covid-19 pandemic not allow face-to-face teaching, remote teaching in synchronous or asynchronous mode will be guaranteed; this will be communicated in good time to students.

Information on office hours available on the teacher's personal page at http://docenti.unicatt.it/.