Code: MAT/03 - Geometry
Credits: 6
Matter: Introduction to Calculus
Main language of instruction: Italian

Teaching Staff
Head instructor:
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Introduction

The aim of this course is giving the students the mathematical tools to engage their curricula in Civil Engineering and Industrial Engineering. In particular they will learn the basics of the mathematical language, from the algebraic calculus to some fundamentals of mathematical analysis.
Also thanks to the execution of the e-tivities, they will develop the necessary competencies to reach the following objectives.

Objectives

The course of Introductory Calculus has the following educational objectives:
1. recall some fundamental facts from elementary algebra and set theory;
2. illustrate the basic properties of complex numbers;
3. illustrate the resolution of the main types of equations and inequalities with one variable;
4. introduce the elementary theory of numerical sequences;
5. introduce the elementary theory of numerical series.

Competencies:

1. *Knowledge and understanding:* At the end of the course, the student should be able to read and understand a mathematical formula and he/she will understand the concept of function and the concept of sequence: in particular their limits, with focus on infinite series.
2. *Applying knowledge and understanding:* At the end of the course, the student should be able to manipulate algebraic expression and solve equations and inequalities, describing the properties of all elementary functions (polynomial functions, power functions, exponential functions, logarithmic functions, trigonometric functions). The student will be able to compute simple limits and infinite series.

3. *Independent judgement:* At the end of the course, the student should be able to identify autonomously the best formulation to adopt for the study of a problem related with the subject of the course, reaching the conclusion in a short time and limiting, as far as possible, the complexity of the computations.
4. *Communications skills:* At the end of the course, the student will develop a scientific, rigorous language, that allows a correct communication, without ambiguity, on the acquired knowledge.
5. *Learning skills:* At the end of the course, the student will develop a substantial knowledge on the fundamentals of mathematics, in order to continue her/his Engineering studies with good maturity and autonomy. Moreover, the students will achieve mastery on the numerous educational tools available (online teaching, forum, e-tivity…).

Syllabus

Programme of the course:

Module 1: SET OF NUMBERS AND ELEMENTARY ALGEBRA

Sets and set operations. Natural Numbers, Integer Numbers, Rational Numbers, Irrational Numbers.

Real Numbers: field axioms, order axioms, Completeness axiom, geometric interpretation of real numbers.

Summary of elementary algebra: elementary formulas (differences of squares, square and cube of a binomial, differences and sums of cubes, Newton binomial), polynomial function with one real variable, root of a polynomial, factorisation methods (common factor, Ruffini's Rule), division between polynomials.

Module 2: COMPLEX NUMBERS

Complex numbers: geometric, algebraic, polar and exponential representation of a complex number, field properties, absolute value, conjugates, powers, n-roots of a complex number.

Module 3: FUNCTIONS

Theory of functions: domain, codomain, injective functions, surjective functions, bijections, invertible functions, composition of functions, monotone functions. Graph of a function.

Elementary functions: linear functions, absolute value, powers, roots, polynomial functions, quadratic functions, rational functions, exponential functions, logarithmic functions, trigonometric functions. Theorems on triangles.

Module 4: EQUATIONS AND INEQUALITIES
Equations and inequalities: linear, absolute values, polynomials of degree two, polynomials of degree greater than two, rational, irrational, exponential, logarithmic, trigonometric.

Module 5: NUMERICAL SEQUENCES
Definition of limit. Uniqueness of limit, convergent sequences, divergent sequences, oscillating sequences, bounded sequences. Algebraic operations with limits. Indeterminate forms, list of particular limits. Squeeze theorem, infinitesimal sequences, monotone sequences. Ratio test for sequences. Order of infinity. Asymptotic sequences.

Module 6: NUMERICAL SERIES
Definition and basic properties. Necessary condition for convergence. Cauchy condition. Sum of series, product with a scalar. Geometric series. Harmonic series. Telescoping series.
Convergence tests for non-negative term series: Direct Comparison test, Limit Comparison test, Ratio test, Root test.
Test for non-constant sign series: Leibniz test, Absolute convergence test.

Evaluation system and criteria
Maximum degree: 30/30 cum Laude.
Details:
28/30: Written examination,
03/30: E-tivity / multiple choice questions.

Bibliography and resources
1. *Materials to consult:*

Teaching materials are provided by the teacher. The educational material on the platform is divided into 6 modules. They completely cover the program and each of them contains lecture notes, slides and video lessons in which the teacher comments on the slides. This material contains all the elements necessary to deal with the study of the course.

2. *Recommended bibliography:*

- Schaum's Outline of Calculus, 6th Edition, Frank Ayres and Elliott Mendelson, McGraw Hill 2013

- Schaum's 3,000 Solved Problems in Calculus, Elliott Mendelson, McGraw-Hill Education 2009