Code: MAT/05
Credits: 9
Matter: Calculus I
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 "Calculus I" is an introductory course to calculus of functions of one variable. It starts with limit and continuity of functions, derivative and its geometrical meaning and properties, graphing of functions. Then it covers indefinite integral, basic integration methods and integrating rational functions, definite integral and its applications.

Prerequisites

It is necessary that the student who approaches the preparation of this subject has a good command of some basic subjects, typically treated in high school and revised in the course of "Introduction to Calculus", such as:

- Algebraic equations and inequalities of first and second degree;
- Resolution of some algebraic equations higher than the second degree;
- Equations and inequalities with absolute and irrational values;
- Fundamental goniometric functions. Associated arches. Elementary goniometric equations and inequalities. Theorems on right-angled triangles.

Objectives and Competencies

Students will:

- Apply arithmetic, algebraic, geometric and logical reasoning to solve problems;
- Represent and evaluate basic mathematical and/or logical information numerically, graphically, and symbolically;
- Interpret mathematical and/or logical models such as formulas, graphs, tables and schematics, and draw inference from them.

Students will become proficient in techniques of differentiation, understand the concept of rate of change and how to use it to solve real world problems, the concept of definite and indefinite integral and their relations to area and rate of change. In particular, the students will:

- Be able to explain the concept of continuous functions;
- Compute instantaneous rate of change;
- Compute derivatives of polynomial and transcendental functions;
- Derive to solve related rate and optimization problems;
- Compute definite and indefinite integrals.

Structure of the course

The course is distributed in 4 modules by thematic areas:

- Module 1: Limits of functions
- Module 2: Continuous functions
- Module 3: Derivatives and graphing of functions
- Module 4: Integration of functions

When the student deems to have acquired the knowledge and skills provided in one module, he will be able to access the relevant assessment, named etivity, uploaded to the platform.

Syllabus

Programme of the course:

Module 1: Limits of functions. Preliminaries: functions, domain, range, graphs, lines, slope, elementary functions. The idea of limits. Definitions of limits. One-side limits. Infinite limits. Limits at infinity. Properties of limits: uniqueness and existence of limits, limits of inequalities, Sandwiching Theorem, algebra of limits, limits of composite functions, limits of monotone functions. Continuity at a point. Remarkable limits. Landau notation: infinite and infinitesimal asymptotics.

Module 2: Continuous functions. Elementary concepts of topology: external, internal, frontier and accumulation points, open and closed sets. Bolzano-Weierstrass Theorem. Compactness. Continuous functions on an interval: Theorem of the existence of zeros; continuity of the inverse function; Weierstrass Theorem. Notes on uniform continuity.

Module 3: Derivatives and graphing of functions. Derivates: definition and geometrical meaning. Techniques of differentiation. Derivates of trigonometric functions. Derivatives of exponential functions. Composite functions and the chain

rule. Inverse functions and their derivatives. The Mean Value Theorem. L'Hopital's Rule. Taylor polynomials. Graphing functions: first derivative test; concavity and second derivative test; infinite limits and asymptotes; optimization.

Module 4: Integration of functions. Antiderivatives. Area as limit of a sum. Riemann Sums and the definite integral. The Fundamental Theorem of Calculus. The Mean Value Theorem for integrals. Methods for integrations: integration by parts, change of variables in an integral.

Evaluation system and criteria

The exam consists of a written test and four etivities carried out during the course. The written test normally includes 4 numerical exercises on the main topics covered in the course. During the written test, it is NOT allowed to use handouts, notes, texts or forms. Etivities are evaluated from 0 to 4 points, while 0-27 points are assigned at the written test.

Bibliography and resources

Materials to consult: The educational materials (lectures notes, slides and video lessons) are available on the unicusano platform.

Recommended text:

- Robert A. Adams, Christopher Essex. Calculus: A Complete Course, 9th Edition. Pearson 2018.
- Frank Ayres and Elliott Mendelson. Schaum's Outline of Calculus, 6th Edition. McGraw Hill 2013
- Elliott Mendelson. Schaum's 3000 Solved Problems in Calculus. McGraw Hill Education 2009.