Fakultät für Ingenieurwesen
Facoltà di Ingegneria
Faculty of Engineering

COURSE DESCRIPTION – ACADEMIC YEAR 2024/2025

Course title	**Mathematical Analysis II**
Course code	42127
Scientific sector	MAT/07
Degree	Industrial and Mechanical Engineering – L9
Semester	2°
Year	1°
Credits	10
Modular	No

Total lecturing hours	64
Total lab hours	30
Attendance	Suggested
Prerequisites	Although there are no formal prerequisites, knowledge of the content of the courses of Mathematical Analysis I and Geometry is strongly recommended.
Course page	Microsoft Teams

Specific educational objectives	The course belongs to the "area di apprendimento di base", and more specifically to the scientific area of mathematics, informatics, statistics. It is a core course. The course provides a general overview of scientific tools and contents. The educational objectives of the course are given by the knowledge of the concepts and techniques of multivariable differential calculus, vector functions and vector fields. Such a knowledge is necessary for an understanding of the content of several among the courses in the bachelor program. The emphasis is on the ability to formulate in mathematical terms and then solve problems involving several variables, and in particular geometric-type problems in a three-dimensional space, to find relative and absolute maxima and minima of functions of two or more variables, to find constrained maxima and minima, to calculate simple double and triple integrals, with special attention to those of interest in mechanics and physics, to know how to employ spherical and cylindrical coordinates, to calculate simple curvilinear or surface integrals, both of a scalar and a vector field. Also, an introduction to the theory of ordinary differential equations is part of the course. For example, students learn how to solve certain linear equations. Finally, if there is time, the use of a software as Maple or Mathematica in connection with the topics in the course is illustrated to the students.

Lecturer	Prof. Maria Letizia Bertotti https://www.unibz.it/en/faculties/engineering/academic-staff/person/26965-maria-letizia-bertotti
Contact	Building K, Room 2.12 (at least up to February 2024) e-mail: MariaLetizia.Bertotti@unibz.it tel. 0471 017130
Scientific sector of lecturer	MAT/07
Teaching language	Italian
Office hours	by appointment
Lecturing Assistant (if any)	
Contact LA	
Office hours LA	
List of topics	• Functions of several variables (differential calculus) • Vector functions, curves and vector fields • Double and triple integrals • Line integrals and surface integrals • Elements of Ordinary Differential Equations (essentially, linear equations) Detailed description: Functions of several real variables. Generalities. Limits and continuity. Partial derivatives. Higher order derivatives. Partial derivatives of composed functions. Linear approximation and differentiability. Vector valued functions: Jacobian matrix. The gradient and directional derivatives. Taylor formula and approximations. Local and global maxima and minima. Hessian matrix. Critical points and their classification. Constrained maxima and minima: Lagrange multiplier method. Elements of linear programming. Curves. Length of a curve. Curvilinear integrals of scalar functions and vector fields. Conservative fields. Necessary conditions and sufficient conditions for a field to be conservative. The gradient, the divergence and the rotor and their applications in physics. Double and triple integrals. Surface integrals of scalar functions and vector fields (flows). The Gauss, Green, Stokes theorems. Models expressed by differential equations. Explicit systems of differential equations of the first order. Existence and uniqueness of the solution of a Cauchy problem. Differential equations of the second order. Linear equations with constant coefficients, homogeneous and non-homogeneous. Examples from physics and other disciplines.
Teaching format	Frontal lectures and exercises.

Learning outcomes	Knowledge and understanding: • Knowledge and understanding of concepts, symbolism, and techniques of multivariable differential calculus and of vector differential calculus. Knowledge and understanding of basic mathematical modelling and basic elements of differential equations. Applying knowledge and understanding: • Applying knowledge and understanding in solving exercises and problems (in particular, arising in engineering) that require formalization, tools and methods learned in the course,

	for example, finding absolute, relative, or constrained maxima and minima of functions of several variables, calculating simple double and triple integrals, curvilinear and surface integrals of both scalar and vector fields, finding the solutions of specific linear ordinary differential equations. Making judgments: • Ability to choose a right approach and convenient tools towards tackling problems and questions which can be mathematically formulated. Communication skills: • Ability to report on the calculations in a clear and effective way. Learning skills: • Ability to autonomously extend and adapt the acquisition and assimilation of the symbolism, methods and tools of this course for the understanding of the content of a consistent part of the courses in this academic curriculum.
Assessment	Written exam consisting in a number of exercises containing various specific questions, relative to the topics of the program. The student receives a form (a folded A3 sheet of paper, with four pages) prepared by the lecturer, on which reporting, for every exercise, both the theoretical formulae or arguing which justify the choice of the methods and tools employed by the student and the calculations which lead to the result. This allows the evaluation of 1. the knowledge and understanding of the course issues: indeed, the student must understand the questions and place them exactly in the context of the theory explained in the course (weight in awarding marks is 30%); 2. the ability to apply acquired knowledge and understanding: the student must solve the exercises, thus applying the theoretical knowledge and understanding of the course issues (weight in awarding marks in connection with the methods employed is 30%). Of course, also the fact whether calculations are correct or not is significant (weight in awarding marks is 10%); 3. the making judgements: the student chooses solution method, which is not always unique and the ability of making judgments is evaluable based on this choice (weight in awarding marks is 10%); 4. the clarity and completeness of the description: they allow evaluation of communication skills (weight in awarding marks is 10%). 5. Altogether, the way how the written examination is worked out allows to assess the learning skills of the student (weight in awarding marks is 10%). **WARNING**: If, as it happened during Covid epidemic, it will be impossible organizing exams in presence, a different examination

	method will be adopted and communicated in time. Exam will be possibly oral (written-oral with an online whiteboard).
Assessment language	Italian
Assessment Typology	Monocratic
Evaluation criteria and criteria for awarding marks	The evaluation is expressed through a unique mark. For the exam to be passed, the mark must be greater or equal to 18/30. Shortly, the following are relevant for the evaluation: the identification of a adequate solution method, the knowledge about which formulae and/or tools to apply and/or use, the logic and clarity of the argument, the ability to correctly complete the exercises, the number of exercises solved.
Required readings	Robert A. Adams & Christopher Essex, Calcolo Differenziale 2. Funzioni di più variabili, Casa Editrice Ambrosiana (2014), or also one of the previous versions, for example: Robert A. Adams, Calcolo Differenziale 2. Funzioni di più variabili, Casa Editrice Ambrosiana (2007). Subject Librarian: David Gebhardi, David.Gebhardi@unibz.it and Ilaria Miceli, Ilaria.Miceli@unibz.it
Supplementary readings	
Software used	*Communicate needed software and technical requirements in advance to it-engineering@unibz.it*