Syllabus

Course Description

Course Title	Classical Mechanics
Course Code	42176
Course Title Additional	
Scientific-Disciplinary Sector	MATH-04/A
Language	Italian
Degree Course	Bachelor in Industrial and Mechanical Engineering
Other Degree Courses (Loaned)	
Lecturers	Prof. Maria Letizia Bertotti, MariaLetizia.Bertotti@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/26965
Teaching Assistant	
Semester	First semester
Course Year/s	2
CP	6
Teaching Hours	36
Lab Hours	24
Individual Study Hours	90
Planned Office Hours	18
Contents Summary	• Linear and angular momentum equations • Euler angles, inertia tensor and rigid body dynamics • Holonomic systems • Lagrange equations • Lyapunov stability (Note: naturally, the treatment of these topics requires the introduction of preparatory concepts and methods).
Course Topics	Kinematics issues: space and time, velocity and acceleration, relative motion, the vector angular velocity, rotations and rotation

	matrices, Euler angles. Newton laws. Active and reactive forces. Dynamics of a (free and constrained) material point. Dynamics of a system composed by a finite number of material points. The laws of mechanics. Mechanical quantities. Inertia tensor. Inertia principal axes. Linear and angular momentum equations. Dynamics of the rigid body (free, with a fixed point, with a fixed axis). Permanent rotations and their stability. Precession motion. Holonomic systems. Ideal constraints. Lagrange equations. Equilibrium, stability. Elements of qualitative analysis.
Keywords	Kinematics (relative motions, rotations, Euler angles) Dynamnics (material point, mechanical system, rigid body) Linear and angular momentum equations Lagrange equations Lyapunov stability
Recommended Prerequisites	Differential calculus for functions of one and more real variables, simple, double and triple integrals, elements of ordinary differential equations. Vectors, matrices.
Propaedeutic Courses	Although there are no compulsory prerequisite courses, knowledge of the content of the Geometry, Mathematical Analysis I and Mathematical Analysis II courses is strongly recommended.
Teaching Format	Frontal lectures and exercises. Some hours will be dedicated to topics of interest in the context of the experiential learning program of the Faculty, relative to the mechanical design of a drone.
Mandatory Attendance	Suggested.
Specific Educational Objectives and Learning Outcomes	The course belongs to the "area di apprendimento di base", and more specifically to the scientific area of mathematics, informatics, statistics. The course is offered within the Mechanical Engineering branch. In this branch, it is a core course. The course gives a general overview of scientific contents. The educational objectives of the course are to provide both formulation and analytical investigation of mathematical models of some classical problems especially focusing on their dynamics. The course provides a rigorous definition and systematisation of that part of physics which studies the motion of bodies and systems. More specifically, the analytical approach of RM, which employs for the description and study of physical problems, concepts and tools

	of geometry and mathematical analysis, is highly significant: through the construction and analytical investigation of models, it combines a theoretical approach with the description of systems of interest in mechanical engineering. The RM course provides a link between topics and tools learned in basic mathematics courses and professional and applied courses that characterise the training of an engineer. A part of the lectures will also be involved in the Experiential Learning Program of the Faculty related to the mechanical design of a drone. Knowledge and understanding: • Knowledge and understanding of the laws of classical mechanics and their translation into differential equations governing the motion of systems of material points, of the rigid body, of holonomic systems. Applying knowledge and understanding: • Ability in calculating mechanical quantities such as, e.g., the kinetic energy, the linear and the angular momentum (with respect to a given point) of a rigid body, the kinetic energy of a holonomic system. Ability in writing the differential equations which describe the evolution in time of a mechanical system; ability in finding equilibrium solutions and in investigating their stability/instability properties. Making judgments: • Ability to describe analytically and through suitable mathematical tools mechanical systems of interest in engineering. Communication skills: • Ability to answer theoretical questions and to report on calculations in the exercises in a clear and effective way. Learning skills: • Ability to autonomously extend the knowledge acquired through the study of classical mechanics to treat cases in which new models are to be introduced and formulated by means of differential equations.
Specific Educational Objectives and Learning Outcomes (additional info.)	
Assessment	Written exam consisting in one or more exercises with specific questions and one or more theoretical questions relative to topics

	in 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 theoretical formulae and arguing which justify the choice of the methods and tools employed by the student and the calculations which lead to the final result. This allows an assessment of the knowledge and understanding of the course issues, as well as the ability to apply the acquired knowledge and understanding and the "making judgements". This last is valuable based on the choice of suitable solving methods and on the answer to theoretical questions. The clarity and completeness of the description allows an evaluation of communication skills. Altogether, the way how the written examination is worked out allows to assess the learning skills of the student. Note: if it will be impossible organizing exams in presence, the exam will be oral (written-oral with an online whiteboard).
Evaluation Criteria	The evaluation is expressed through a unique mark. For the exam to be passed, the mark has to be greater or equal to 18/30. Relevant for assessment are: the identification of a suitable solution method, the knowledge about which formulae and/or tools to apply and/or use, the logic and clarity of the arguing, the ability to correctly complete exercises, the number of exercises solved and the way how theoretical questions are answered.
Required Readings	M.L. Bertotti & G. Modanese, *Elementi di meccanica razionale. Una prospettiva dinamica,* Edizioni Scientifiche Italiane (2015). Subject Librarian: David Gebhardi, David.Gebhardi@unibz.it and Ilaria Miceli, Ilaria.Miceli@unibz.it
Supplementary Readings	For exercises: F. Bampi, M. Benati, A. Morro. *Problemi di meccanica razionale*, ECIG, Genova.
Further Information	
Sustainable Development Goals (SDGs)	Reduced inequalities, Quality education