Syllabus

Course Description

Course Title	Mechanics of Machines and Mechanism for Automation
Course Code	42185
Course Title Additional	
Scientific-Disciplinary Sector	IIND-02/A
Language	Italian
Degree Course	Bachelor in Industrial and Mechanical Engineering
Other Degree Courses (Loaned)	
Lecturers	Prof. Andrea Giusti, Andrea.Giusti@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/47728
Teaching Assistant	
Semester	All semesters
Course Year/s	3
CP	10
Teaching Hours	60
Lab Hours	36
Individual Study Hours	154
Planned Office Hours	28
Contents Summary	The course belongs to the type "caratterizzanti" – areas: mechanics and automation. It aims at teaching both scientific foundations and practical methods. The course aims at introducing the necessary skills for understanding the basic principles of the mechanics of automatic machines and their functional design and analysis. • Degrees of Freedom, kinematic pairs, kinematic scheme of a mechanism, structure equation; • Kinematic analysis of mechanisms (position, velocity, acceleration);

	• Static and dynamic analysis of (planar) mechanisms. Lagrange's equations; • Mechanisms for automatic machines: motion generation; cam mechanisms; motion irregularities; • Mechanics of Drives: motor-gear-load coupling (introduction); • Mechanics of Robots: introduction to 3D kinematics and industrial robots.
Course Topics	Introduction and fundamentals. Basic concepts and definitions for the study of mechanisms. Degrees of freedom, kinematic pairs and structure equation. Kinematic analysis of planar mechanisms. Kinematic analysis of position, velocity and acceleration (by base and dyads mechanisms). Singular configurations. Examples. Static and dynamic analysis of planar mechanisms. Recalls on Newtonian and Lagrangian approach. Newtonian and Lagrangian method for the static analysis of planar mechanisms. Application examples. D'Alembert's principle. Equation of dynamic equilibrium for mechanisms. Lagrange's equation. Inertia reduced to the free coordinate. Motion irregularities. Mechanisms for automatic machines: introduction to the laws of motion; generation of movements - reciprocating, and translational motion. Cam mechanisms and mechanisms for unidirectional and intermittent motion. Mechanics of drives: introduction, basic concepts on motor-load coupling with and without gearbox. Mechanics of robots: introduction, 3D kinematics of robot, introduction to the Denavit-Hartenberg convention, characteristics of the main industrial robots, robot simulation.
Keywords	Kinematics, Dynamics, Mechanisms, Mechanics of drives, Robots
Recommended Prerequisites	Mechanics of Structures.
Propaedeutic Courses	
Teaching Format	The topics are presented by the professor by means of Power Point presentations or the blackboard. Practical parts and lab activities/exercises (e.g. Matlab, WorkingModel, Simscape Multibody or MSC Adams) are planned. A selection of the material presented in class and useful material will be available in the course reserve collection database.
Mandatory Attendance	Attendance is not compulsory.

Specific Educational Objectives and Learning Outcomes	Students will learn, in the first part of the course, fundamental concepts and methodologies for the functional design and kinematic (and dynamic) study of the mechanisms used in automatic machines; in the second part of the course, students will acquire skills related to (i) the sizing of components to be used in automatic machines to generate predefined movements and (ii) robotic systems used in automated systems. Knowledge and understanding 1. Knowledge and understanding of applied mechanics fundamentals. 2. Knowledge and understanding of the main mechanical components and their applications. 3. Knowledge of the main mechanisms and robots used in automatic machines and their function. Applying knowledge and understanding 4. Ability to formulate the equilibrium conditions for a mechanical system. 5. Ability to apply the learned principles in the study of planar mechanisms. 6. Ability to apply the learned principles for the synthesis of mechanisms for automatic machines and the choice of robotic systems. Making judgements 7. Making judgments for choosing the suitable mechanical component or kinematic solution. Communication skills 8. Ability to present the acquired knowledge and competences with a proper language. Learning skills 9. Ability to autonomously extend the knowledge acquired during the study course.
Specific Educational Objectives and Learning Outcomes (additional info.)	
Assessment	- Summative assessment. Written exam with exercises and questions: 60% written exam, exercises: 2 exercises (100 minutes); ILOs assessed: 1 - 8; 40% written exam, theory: 4 questions. (80 minutes): ILOs

	assessed: 1,2,4,6,7. - Optional midterm test on the first part of the course, consisting of questions and an exercise: 60% optional midterm written test:1 exercise (50 minutes); ILOs assessed: 1 - 5, 8; 40% optional midterm written test, theory: 2 questions. (40 minutes); ILOs assessed: 1-3, 8. The result of the optional midterm test, if sufficient (>=18/30), may be considered, for the entire academic year, as the grade for the first part of the course content. In this case, the final written exam result will be computed as the arithmetic mean of the optional midterm test result and the written exam result for the second part of the course.
Evaluation Criteria	Theoretical knowledge (35%) Correctness of methods (35%) Correctness in solution (30%)
Required Readings	Notes from the lectures. Handouts provided by the lecturer. Subject Librarian: David Gebhardi, David.Gebhardi@unibz.it and Ilaria Miceli, Ilaria.Miceli@unibz.it
Supplementary Readings	M. Callegari, P. Fanghella, F. Pellicano, Meccanica applicata alle macchine, Ed. Utet Università. M. Giovagnoni, A. Rossi, Una introduzione allo studio dei meccanismi, Ed. Cortina, Padova G. Jacazio, S. Pastorelli, “Meccanica applicata alle macchine”, Ed. Levrotto e Bella, Torino B. Siciliano, L. Sciavicco, L. Villani, G. Oriolo, "Robotica - Modellistica, pianificazione e controllo", McGraw-Hill Education, 3a edizione. G. Legnani, M. Tiboni, R. Adamini, D. Tosi, "Meccanica degli Azionamenti. Azionamenti Elettrici", Società Editrice Euscalpio. 3a edizione.
Further Information	Software used (possible): Matlab, WorkingModel, Simscape Multibody or MSC Adams.

Sustainable Development Goals (SDGs)	Industry, innovation and infrastructure, Decent work and economic growth