Syllabus

Course Description

Course Title	Reverse Engineering and Rapid Prototyping
Course Code	42170
Course Title Additional	
Scientific-Disciplinary Sector	IIND-03/B
Language	English
Degree Course	Bachelor in Industrial and Mechanical Engineering
Other Degree Courses (Loaned)	
Lecturers	Prof. Yuri Borgianni, Yuri.Borgianni@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/35189 dr. Lorenzo Maccioni, Lorenzo.Maccioni@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/37418
Teaching Assistant	
Semester	First semester
Course Year/s	3, 4
CP	6
Teaching Hours	36
Lab Hours	24
Individual Study Hours	90
Planned Office Hours	
Contents Summary	The course aims to provide the fundamental knowledge to manage components in both physical and digital format. The main topics are: • Introduction to the Engineering Design process and CAD; • Reverse Engineering and 3D scanning; • Additive Manufacturing technologies; • Special applications of and new trends in Additive

	Manufacturing; • Design for Additive Manufacturing; • Employment of Reverse Engineering and Rapid Prototyping technologies in different industrial fields; • Other technologies for the prototyping and the design of products.
Course Topics	- Notions of the Engineering Design process and parametric 3D CAD - Reverse Engineering and 3D scanning o Objectives and common application fields o Existing technologies o Contact systems o Active non-contact systems o Manipulation of acquired data, post-processing o Interface between Reverse Engineering and Computer-Aided Design systems o Industrial applications of Reverse Engineering o Photogrammetry and use of Reverse Engineering in non-industrial fields - Additive Manufacturing technologies o Vat Photopolimerization, Stereolitography (SLA) o Material Extrusion, Fused Deposition Modelling (FDM) o Powder Bed Fusion o Directed Energy Deposition o Material Jetting o Binder Jetting o Sheet Lamination - Opportunities and issues in Additive Manufacturing - Sustainability concerns in Additive Manufacturing - Design for Additive Manufacturing - Introduction to other technologies for the prototyping and the design of products.
Keywords	Reverse Engineering, 3D scanners, Rapid Prototyping, Additive Manufacturing, CAD
Recommended Prerequisites	None.
Propaedeutic Courses	
Teaching Format	The course takes place through frontal lectures, tutorials, seminars, presentations of laboratory activities, and a teaching excursion.

	The lecturer can be contacted through email by students for questions and clarifications by appointment.
Mandatory Attendance	Recommended, not compulsory.
Specific Educational Objectives and Learning Outcomes	The course addresses the fundamentals of methods and techniques to support engineering design processes, by focusing on the opportunities provided by Reverse Engineering and Rapid Prototyping. The contents of the teaching are tailored to students of the Automation major. Students will achieve first a general understanding of product development processes. Then, the course will clarify the design phases and the circumstances in which Reverse Engineering and Rapid Prototyping are the most advantageous. The major families of Additive Manufacturing technologies will be presented; their orientation towards prototyping and/or manufacturing of end products will be dealt with. The last part of the course will focus on the use of the discussed technologies in industry, along with alternative technologies to be used in engineering design. Students will have the opportunity to experience available tools in a lab setting. The combination of theoretical findings and practical activities enables both the strengthening of students' scientific background and the acquisition of valuable professional skills. 1. Knowledge and understanding Students will i. acquire basic knowledge about the main objectives pursued by Reverse Engineering and Rapid Prototyping tools, with a particular focus on their use to design and develop new engineering products; ii. understand the main differences, pros and cons of the alternative technologies to carry out design tasks supported by 3D-printing devices targeting Rapid Prototyping iii. acquire knowledge about some important Additive Manufacturing processes; iv. be able to identify the advantages and limitations of Reverse Engineering and Additive Manufacturing processes in the overall context of design, manufacturing and industrial engineering.

	2. Applying knowledge and understanding Students will have the chance to apply their knowledge to master processes involving Reverse Engineering, Rapid Prototyping and modelling techniques with a hands-on approach by the chance to access some software applications. 3. Making judgements Students will be able to compare the existing tools that have been developed for 3D scanning and Rapid Prototyping. They will develop critical capabilities about the pros and cons regarding said instruments. In addition, they will be able to explain alternative strategies for achieving the results obtained through Reverse Engineering and Rapid Prototyping within engineering design. 4. Communication skills Students will have the ability to properly discuss the fundamentals of Reverse Engineering and Rapid Prototyping. 5. Learning skills Students will be able to combine the knowledge acquired during the course with respect to the theoretical background of the teaching, the experience gathered by means of tests and notions about trends in the field, gained through recent literature in the domain. • Students will have the opportunity to extend the knowledge of the topics of the course by consulting scientific literature, specialized texts, practitioners' materials or websites that the lecturer will suggest during the course.
Specific Educational Objectives and Learning Outcomes (additional info.)	-
Assessment	- Summative assessment: The final exam is a written test (4 hours available to students), which mainly assesses the knowledge and understanding of the topics of the course (1.). Specific questions and exercises are tailored to assess students' capabilities to make judgements and selections (3.), their learning skills (5.), as well as their understanding of the objectives of the practical activities (2.). To this respect, details are found in "Evaluation criteria" below.

Evaluation Criteria	The evaluation criteria of the exam are tailored to test the knowledge of the topics of the course, the clarity of the answers and the appropriateness of the language of the student, the pertinence and the relevance of the response and the autonomy of judgment, as well the capability of critically selecting alternatives for product development. Specific questions will aim to assess the ability of the student to present, communicate and discuss design objectives by favorably implementing Reverse Engineering and Rapid Prototyping techniques. Other questions will verify the student's comprehension of the main issues emerged during practical activities, for instance the motivations behind the need to perform auxiliary functions to the scope of successful 3D scanning and printing operations. Additional exercises will be oriented to the evaluation of the skills concerning making of judgements, by proposing potential industrial problems and asking for the most appropriate technologies that might aid in the overcoming of said problems. In the written test, the points achievable by positively completing each exercise and answering each question will be clearly indicated. Points might be subtracted if the quality of the language will be not considered satisfactory, with specific reference to the terms characterizing the teaching.
Required Readings	The course slides are the only required readings. The course material is mainly collected from research papers and web notes.
Supplementary Readings	Students can also refer to the following textbooks (even if not exhaustive of the whole course and redundant with respect to some topics): - Gibson I, Rosen D, Stucker B, Khorasani M, "Additive Manufacturing Technologies", Springer. - Raja, Vinesh, Fernandes, Kiran J. (Eds.), "Reverse Engineering: an Industrial Perspective", Springer. Additional textbooks, lecture notes, and research papers might be suggested by the lecturer during the course to enable student's autonomous study of pertinent topics. Some research papers that have been extensively used to extract contents and materials will be clearly indicated. They can be consulted as alternative sources and to deepen knowledge.

Further Information	Software used: SolidWorks, GOM Inspect (in a few exercises with no previous knowledge required).
Sustainable Development Goals (SDGs)	Quality education