Syllabus

Course Description

Course Title	Design and Manufacturing of Industrial Products
Course Code	47552
Course Title Additional	
Scientific-Disciplinary Sector	
Language	English
Degree Course	Master in Industrial Mechanical Engineering
Other Degree Courses (Loaned)	
Lecturers	Prof. Dr. Walburga Ursula Kerschbaumer, Walburga.Kerschbaumer@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/50265 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	1
CP	10
Teaching Hours	48
Lab Hours	48
Individual Study Hours	0
Planned Office Hours	
Contents Summary	The course is part of characterizing activities for engineering studies, and it is part of the curriculum of study of the Master in Industrial Engineering. The combination of theoretical findings and

	practical activities enables both the strengthening of students' scientific background and the acquisition of valuable professional skills. Module 1 aims to furnish a general overview of the most important advanced technologies and manufacturing systems. At the end of the course, the student will be able to face a manufacturing problem deciding how to process and manage a product and choosing the suitable manufacturing technology (in particular with a focus on some specific advanced technologies such as Additive Manufacturing or Laser). Also, the students will perform a simulation of an additive manufacturing process. Module 2 addresses the fundamentals of methods and techniques to support engineering design processes, by focusing on the opportunities provided by Reverse Engineering and Rapid Prototyping. Students will achieve first a global 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. Within the contents, a discussion about alternative technologies, which will be outlined as well, will be introduced. Students will have the opportunity to experience available tools in a lab setting.
Course Topics	See topics of modules 1 and 2
Keywords	Manufacturing systems, manufacturing decisions, simulation, Additive Manufacturing, 3D scanning, prototypes
Recommended Prerequisites	None.
Propaedeutic Courses	
Teaching Format	See the teaching format of modules 1 and 2
Mandatory Attendance	Recommended.
Specific Educational Objectives and Learning Outcomes	Intended Learning Outcomes (ILO) Module 1 - Advanced Manufacturing Technologies and Systems Knowledge and understanding: 1. This module provides bases and opportunities to originally develop and/or apply knowledge and ideas both in a manufacturing and in a research context.

	Applying knowledge and understanding: 2. Knowledge provided by the lessons will be applied in the development of a project connected to the studied technologies. Making judgements: 3. This module provides the ability to integrate knowledge and handle complexity, and to formulate global judgements as well as specific technologic analysis, evaluating the most suitable production cycle also for complex parts by using advanced technologies. Communication skills: 4. This module provides the ability for the students to work in a group and communicate these conclusions both to specialist and non-specialist audiences. Ability to learn: 5. All the arguments are presented and discussed during the lectures. The study is autonomous, and the students will have the possibility to discuss the achieved knowledge in the development of team course project. Module 2 - Reverse Engineering and Rapid Prototyping Knowledge and understanding: 6. 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 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. Applying knowledge and understanding:

	7. 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. Making judgments: 8. 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. Communication skills 9. Students will have the ability to properly discuss the fundamentals of Reverse Engineering and Rapid Prototyping. Ability to learn: 10. Students will be encouraged to consult the literature and the web to keep themselves updated, because of the rapid evolution of the treated technologies, especially Additive Manufacturing 11. 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 lab tests and notions about trends in the field, gained through the 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	Module 1: - Report and presentation: 30 minutes per group; ILOs assessed: 2, 4, 5; - Case study written: group; max. 2 hours; ILOS assessed: 1, 3. Module 2: - Written exam: max. 4 hours; ILOs assessed: 6, 8, 9. Formative assessment:

	The group exercises in the classroom and in the laboratory through experiential learning, conversations with the lecturer and the performance in specific tasks would enable the assessment and evaluation of the students' ability to apply their knowledge and understanding of the topics (7.) covered during the course, as well as their achieved communication skills (9.). Summative assessment: The final exam is a written test, which mainly assesses the knowledge and understanding of the topics of the course (6.). Specific questions and exercises are tailored to assess students' capabilities to make judgements and selections (8.), and their understanding of the objectives of the practical activities (7.). To this respect, details are found in "Evaluation criteria" below. The ILO (10) will not be assessed.
Evaluation Criteria	Module 1 Written exam (50%) and specific tasks, written report and oral project presentation (50%) • Relevant for written exam: clarity of answers, ability to summarize, evaluate, and establish relationships between topics, use of drawing and scheme of the processes; • Relevant for project: ability to work in a team, creativity, skills in critical thinking, ability to identify new solutions using the described technologies. Module 2 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 supporting engineering design processes. Specific questions will aim to assess the ability of the student to present, communicate and discuss the design objectives favored by Reverse Engineering and Rapid Prototyping techniques. Other questions will verify the student's comprehension of the main practical 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 could be oriented to the evaluation of the judgement skills 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 maximum number of 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 considered unsatisfactory, with specific reference to the terms characterizing the teaching. Please note that the final mark for the course "Design and Manufacturing of Industrial Products" will be the average of the marks achieved in the modules "Reverse Engineering and Rapid Prototyping" and "Advanced Manufacturing Technologies and Systems". Assessment language: English
Required Readings	• Slides of the course. • The course material is mainly collected from research papers and web notes.
Supplementary Readings	**Module 1** Boothroyd G, Dewhurst P, Knight WA, Production Design for Manufacture and Assembly, Taylor & Francis Group. Hassan E, Advanced Machining Process, McGraw Hill **Module 2** 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	
Sustainable Development Goals (SDGs)	Responsible consumption and production

Course Module

Course Constituent Title	Reverse Engineering and Rapid Prototyping
Course Code	47552A
Scientific-Disciplinary Sector	IIND-03/B
Language	English
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
CP	5
Responsible Lecturer	
Teaching Hours	24
Lab Hours	24
Individual Study Hours	77
Planned Office Hours	
Contents Summary	
Course Topics	o Material Extrusion, Fused Deposition Modelling (FDM) o Powder Bed Fusion o Directed Energy Deposition o Material Jetting o Binder Jetting o Sheet Lamination
Teaching Format	The module is based on frontal lectures, classroom and laboratory

	activities. Excursions and/or expert speeches are foreseen aimed to interact with industrial subjects, especially South Tyrolean companies, relevant for the course topics, e.g. 3D scanners and printers. The topics of the module are reported in the provided lecture notes, as well as in the textbooks of the bibliography and some scientific articles. Before each lecture, the corresponding .pdf presentation will be uploaded in the a bespoke Teams platform. The lecturer can be contacted by students for questions and clarifications by appointment. Discussion during lectures is fostered.
Required Readings	Slides of the course. The course material is mainly collected from research papers and web notes.
Supplementary Readings	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.*

Course Module

Course Constituent Title	Advanced Manufacturing Technologies and Systems
Course Code	47552B
Scientific-Disciplinary Sector	IIND-04/A
Language	English
Lecturers	Prof. Dr. Walburga Ursula Kerschbaumer, Walburga.Kerschbaumer@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/50265
Teaching Assistant	

Semester	First semester
CP	5
Responsible Lecturer	
Teaching Hours	24
Lab Hours	24
Individual Study Hours	77
Planned Office Hours	
Contents Summary	
Course Topics	• Introduction to manufacturing, • CNC evolution, step-nc • Manufacturing systems, • Introduction to Industry 4.0, • Hydroforming and Sheet incremental forming, • Laser, • Plasma Arc Machining, • Electron Beam Machining, • Electrical Discharge Machining, • Water Jet Machining • DfMA • Simulation for manufacturing
Teaching Format	Frontal lectures, exercises, case study (laptops are required for group work).
Required Readings	Slides of the course. The course material is mainly collected from research papers and web notes.
Supplementary Readings	Boothroyd G, Dewhurst P, Knight WA, Production Design for Manufacture and Assembly, Taylor & Francis Group. Hassan E, Advanced Machining Process, McGraw Hill.