Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus
Course description

Course title	Reverse Engineering and Rapid Prototyping
Course code	47502
Scientific sector	ING-IND/15
Degree	Master in Industrial Mechanical Engineering
Semester	1
Year	I
Academic year	2020/21
Credits	5
Modular	No

Total lecturing hours	24
Total lab hours	24
Total exercise hours	-
Attendance	Required
Prerequisites	None
Course page	https://www.unibz.it/en/sciencetechnology/progs/master/industrial-and-mechanical-engineering/default.html

Specific educational objectives	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 characterizing for the students of the M.Sc. course. 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. The combination of theoretical findings and practical activities enables both the strengthening of students' scientific background and the acquisition of valuable professional skills.

Lecturer	Dr. Yuri Borgianni, K0.05 yuri.borgianni@unibz.it +39 0471/017821 https://www.unibz.it/en/faculties/sciencetechnology/academic-staff/person/35189-yuri-borgianni
Scientific sector of the lecturer	ING-IND/15
Teaching language	English
Office hours	Monday to Friday, upon appointment to be agreed through

	email
Teaching assistant (if any)	Maccioni Lorenzo
Office hours	By appointment

List of topics covered	• Introduction to the Engineering Design process
	  ○ Support provided by established and emerging technologies to improve the design process
	• Reverse Engineering and 3D scanning
	  ○ Objectives and common application fields
	  ○ Existing technologies
	  ○ Contact systems
	  ○ Active non-contact systems
	  ○ Manipulation of acquired data
	  ○ Interface between Reverse Engineering and Computer-Aided Design systems
	  ○ Objectives and application fields of passive non-contact systems
	• Additive Manufacturing technologies targeting Rapid Prototyping
	  ○ Vat Photopolimerization, Stereolitography (SLA)
	  ○ Material Extrusion, Fused Deposition Modelling (FDM)
	  ○ Material Jetting
	  ○ Binder Jetting
	  ○ Sheet Lamination
	• Design for Additive Manufacturing
	• Employment of Reverse Engineering and Rapid Prototyping technologies in different industrial fields
	• Other technologies for the prototyping and the evaluation of products
	  ○ Use of Virtual Reality in engineering design
	  ○ Biometric systems, eye tracking

Teaching format	The course 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 course 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 Open Learning Environment platform. The lecturer can be contacted by students for questions and clarifications by appointment. Discussion during lectures is fostered.

Learning outcomes	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 predominantly used for the fabrication of prototypes; 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. 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 lab tests and notions about trends in the field, gained through the 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.

Assessment	**Formative assessment** The group exercises in the classroom and in the

	laboratory through hands-on experiments, 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 (2.) covered during the course, as well as their achieved communication skills (4.). **Summative assessment** The final exam consists in a written test, 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.
Assessment language	English
Evaluation criteria and criteria for awarding marks	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 the detailed design phase of engineering design cycles, by favorably implementing 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 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 exercises 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 material is mainly collected from research papers and web notes. Students can also refer to the following textbooks (even if not exhaustive of the whole course and redundant with respect to other topics): - Raja, Vinesh, Fernandes, Kiran J. (Eds.), "Reverse Engineering: an Industrial Perspective", Springer 2008

	- Gibson, Ian, Rosen, David W., Stucker, B., "Additive Manufacturing Technologies – Rapid Prototyping to Direct Digital Manufacturing", Springer 2015
Supplementary readings	Additional textbooks, lecture notes, and research papers will be suggested by the lecturer during the course to enable student's autonomous study of pertinent topics.