

## COURSE DESCRIPTION – ACADEMIC YEAR 2023/2024

<b>Course title</b>	<b>Reverse Engineering and Rapid Prototyping</b>
<b>Course code</b>	42170
<b>Scientific sector</b>	ING-IND/15
<b>Degree</b>	Bachelor in Industrial and Mechanical Engineering
<b>Semester</b>	1
<b>Year</b>	3-4
<b>Credits</b>	6
<b>Modular</b>	No
<b>Total lecturing hours</b>	36
<b>Total lab hours</b>	24
<b>Attendance</b>	Recommended, not compulsory.
<b>Prerequisites</b>	None
<b>Course page</b>	Microsoft Teams group, which will be created before the start of the course
<b>Specific educational objectives</b>	<p>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.</p> <p>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.</p> <p>Students will have the opportunity to experience available tools in a lab setting.</p> <p>The combination of theoretical findings and practical activities enables both the strengthening of students' scientific background and the acquisition of valuable professional skills.</p>
<b>Lecturer</b>	Prof. Yuri Borgianni, <a href="https://www.unibz.it/en/faculties/engineering/academic-staff/person/35189-yuri-borgianni">https://www.unibz.it/en/faculties/engineering/academic-staff/person/35189-yuri-borgianni</a>
<b>Contact</b>	Office L4 (building of the Region, 4th floor), e-mail: <a href="mailto:yuri.borgianni@unibz.it">yuri.borgianni@unibz.it</a> , phone: +39 0471/017821
<b>Scientific sector of lecturer</b>	ING-IND/15
<b>Teaching language</b>	English
<b>Office hours</b>	Office hours are possible Monday to Friday, upon appointment to be agreed through e-mail

<b>Lecturing Assistant (if any)</b>	Under assignment
<b>Contact LA</b>	
<b>Office hours LA</b>	
<b>List of topics</b>	<ul style="list-style-type: none"> <li>● Introduction to the Engineering Design process and CAD</li> <li>● Reverse Engineering and 3D scanning           <ul style="list-style-type: none"> <li>○ Common objectives</li> <li>○ Existing technologies</li> <li>○ Contact systems</li> <li>○ Active non-contact systems</li> <li>○ Manipulation of acquired data</li> </ul> </li> <li>● Additive Manufacturing technologies           <ul style="list-style-type: none"> <li>○ Vat Photopolimerization, Stereolitography (SLA)</li> <li>○ Material Extrusion, Fused Deposition Modelling (FDM)</li> <li>○ Powder Bed Fusion</li> <li>○ Directed Energy Deposition</li> <li>○ Material Jetting</li> <li>○ Binder Jetting</li> <li>○ Sheet Lamination</li> </ul> </li> <li>● Special applications of and new trends in Additive Manufacturing</li> <li>● Design for Additive Manufacturing</li> <li>● Employment of Reverse Engineering and Rapid Prototyping technologies in different industrial fields</li> <li>● Other technologies for the prototyping and the design of products</li> </ul>
<b>Teaching format</b>	<p>The course takes place through frontal lectures, tutorials, seminars, presentations of laboratory activities, and a teaching excursion. The lecturer can be contacted by students for questions and clarifications by appointment.</p>

<b>Learning outcomes</b>	<ol style="list-style-type: none"> <li>1. <u>Knowledge and understanding</u>          Students will         <ol style="list-style-type: none"> <li>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;</li> <li>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</li> <li>iii. acquire knowledge about some important Additive Manufacturing processes;</li> <li>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.</li> </ol> </li> <li>2. <u>Applying knowledge and understanding</u>          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.</li> <li>3. <u>Making judgements</u></li> </ol>
--------------------------	---

	<p>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.</p> <p>4. <u>Communication skills</u>        Students will have the ability to properly discuss the fundamentals of Reverse Engineering and Rapid Prototyping.</p> <p>5. <u>Learning skills</u>        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.</p> <ul style="list-style-type: none"> <li>• 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.</li> </ul>
--	---

<p><b>Assessment</b></p>	<p><b>Formative assessment</b>        The attendance of exercise hours, 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.).</p> <p><b>Summative assessment</b>        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.</p>
<p><b>Assessment language</b></p>	<p>English</p>
<p><b>Assessment Typology</b></p>	<p>Monocratic</p>
<p><b>Evaluation criteria and criteria for awarding marks</b></p>	<p>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.</p> <p>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</p>

	<p>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.</p> <p>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.</p>
<p><b>Required readings</b></p>	<p>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):</p> <ul style="list-style-type: none"> <li>- Raja, Vinesh, Fernandes, Kiran J. (Eds.), "Reverse Engineering: an Industrial Perspective", Springer 2008</li> <li>- Gibson, Ian, Rosen, David W., Stucker, B., "Additive Manufacturing Technologies – Rapid Prototyping to Direct Digital Manufacturing", Springer 2015</li> </ul>
<p><b>Supplementary readings</b></p>	<p>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.</p>
<p><b>Software used</b></p>	<p>SolidWorks, GOM Inspect (in a few exercises with no previous knowledge required)</p>