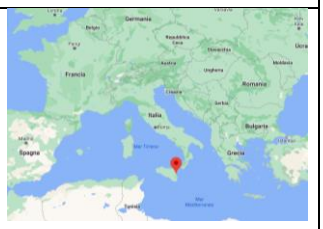
UNIVERSITÀ
degli STUDI
di CATANIA

UNIVERSITY OF CATANIA – ITALY

MSc MECHANICAL ENGINEERING

THREE DIFFERENT CURRICULA:

1) *ADVANCED MECHANICAL DESIGN*
2) *MECHATRONICS AND MANUFACTURING*
3) *ENERGY AND ENVIRONMENT*

University	***Catania and the Mount Etna***	***Location***
		

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Course Overview

The training course includes the following disciplinary areas, grouped in homogeneous themes corresponding to the main professional figures traditionally covered by mechanical and mechatronic engineers:

- modeling and numerical methodologies;
- mechatronics;
- structural design;
- fluid machines;
- production systems;
- energy.

The training path is divided into two years and is differentiated into three curricula. The first year is the same for all three paths. The second year, is divided into three curricula:

1) Advanced mechanical design;
2) Mechatronics and manufacturing;
3) Energy and Enviroment.

The course ends with a thesis that may concern design activities or applied research activities in order to demonstrate not only the mastery of the topics studied but also the ability to address new issues and operate independently within an industrial or research structure.
During the training course there is the possibility to spend a period of study, a thesis preparation and a stage at foreign universities, through Erasmus+ or other programs.
In relation to these purposes, the training path is developed by providing students with specific skills on:

- acquisition of theoretical and practical knowledge for the design of mechanical and mechatronic systems;
- design of mechanical systems through FEM numerical simulation;
- characterization of materials and mechanical components through laboratory tests and non-destructive testing methods;
- realization of components with additive manufacturing rapid prototyping techniques;
- mechatronics of mechanical systems, systems for robotics and industrial automation, modeling of multibody and automotive systems, planning and control of mechanical systems;
- study of internal combustion engines, renewable energy sources, energy technology systems, energy management and environmental impact;
- the organization and control of production;
- the optimization of industrial processes, also considering production and management aspects;
- the automation of production systems;
- the information and computer supports for the design of mechanical systems.

The skills acquired by graduates concern:

- the ability to solve complex technical problems and formulate innovative solutions;
- the ability to design, organize and manage complex and/or innovative processes;
- the ability to communicate and relate within technical and productive organizations.

1 CURRICULUM IN ADVANCED MECHANICAL DESIGN

				Credits			
FIRST YEAR - FIRST PERIOD (October – December)							
		Fluid Mechanics		6			
		Modeling and Simulation of Mechanical Systems		9			
		Materials Science and Technology (2 modules)	1 - Macromolecular chemistry	3			
			2 - Materials Science and Technology	6			
FIRST YEAR - SECOND PERIOD (March – June)							
		Machine Design		9			
		Mechanical and Thermal Measurements		6			
		Manufacturing Process Technology		9			
SECOND YEAR - FIRST PERIOD (October – December)							
		Advanced Manufacturing of Plastics and Composites		6			
		Experimental and Numerical Advanced Design		12			
		Non Destructive Evaluation on Mechanical Elements		6			
		Course selected by the studend *		9			
		Traineeship		6			
SECOND YEAR - SECOND PERIOD (March – June)							
		Fluid Machines Design		9			
		Machine Design II		9			
		Final Thesis		*15*			

** The student can choose a Course from a selected list (a Course of 9 credits from another curriculum or from another International MSc at the University of Catania*: *PHYSICS; CHEMICAL ENGINEERING FOR INDUSTRIAL SUSTAINABILITY; AUTOMATION ENGINEERING AND CONTROL OF COMPLEX SYSTEMS; ELECTRICAL ENGINEERING; ELECTRONIC ENGINEERING)*

2 CURRICULUM IN MECHATRONICS AND MANUFACTURING							
				Credits			
FIRST YEAR - FIRST PERIOD (October – December)							
		Fluid Mechanics		6			
		Modeling and Simulation of Mechanical Systems		9			
		Materials Science and Technology (2 sub-courses)	1 - Macromolecular chemistry	3			
			2 - Materials Science and Technology	6			
FIRST YEAR - SECOND PERIOD (March – June)							
		Machine Design		9			
		Mechanical and Thermal Measurements		6			
		Manufacturing Process Technology		9			
SECOND YEAR - FIRST PERIOD (October – December)							
		Advanced Manufacturing		9			
		Mechatronics		6			
		Vehicles Dynamics and MultiBody Simulation		9			
SECOND YEAR - SECOND PERIOD (March – June)							
		Fluid Machines Design		9			
		Machine Design II		9			
		Course selected by the studend *		9			
		Traineeship		6			
		Final Thesis		*15*			

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3 CURRICULUM IN ENERGY AND ENVIRONMENT							
				Credits			
FIRST YEAR - FIRST PERIOD (October – December)							
		Fluid Mechanics		6			
		Modeling and Simulation of Mechanical Systems		9			
		Materials Science and Technology (2 sub-courses)	1 - Macromolecular chemistry	3			
			2 - Materials Science and Technology	6			
FIRST YEAR - SECOND PERIOD (March – June)							
		Machine Design		9			
		Mechanical and Thermal Measurements		6			
		Manufacturing Process Technology		9			
SECOND YEAR - FIRST PERIOD (October – December)							
		Energy Management		6			
		Energy Systems and Environment		9			
		Thermal Systems		9			
SECOND YEAR - SECOND PERIOD (March – June)							
		Fluid Machines Design		9			
		Machine Design II		9			
		Course selected by the studend *		9			
		Traineeship		6			
		Final Thesis		*15*			

** The student can choose a Course from a selected list (a Course of 9 credits from another curriculum or from another International MSc at the University of Catania*: *PHYSICS; CHEMICAL ENGINEERING FOR INDUSTRIAL SUSTAINABILITY; AUTOMATION ENGINEERING AND CONTROL OF COMPLEX SYSTEMS; ELECTRICAL ENGINEERING; ELECTRONIC ENGINEERING)*

LEARNING OBJECTIVES

Courses	Learning objectives
Advanced Manufacturing	Advanced Manufacturing is the study of the engineering, design, production, and optimization management utilized to remain competitive in today's technologically advanced manufacturing facilities. It entails the study of lean manufacturing techniques used to reduce costs and increase plant efficiency and productivity. We will cover a history of lean concepts including statistical process control, production scheduling, design of manufacturing systems, and much more. There will be an emphasis placed on problem solving including manufacturing systems related issues and an iterative approach to resolution implementation. The course also includes the study of software tools aiming to address both short- and medium- term production planning related problems.
Advanced Manufacturing of Plastics and Composites	The aim of the course is to provide the student with a thorough knowledge on the advanced manufacturing technologies for plastic and composites materials. The student will be first introduced with some concepts and theoretical background on advanced manufacturing techniques for plastics and composites. After this introduction the students will be instructed to gain hand on experience on some of the technologies described theoretically. Among the techniques discussed 3D printing will be a special focus for this course. The full access to the equipment's of the Polymer and Composites Group will be granted to the students at the end of the course to realize some practical projects as part of the final examination.
Energy Management	The course aims to provide knowledge on the energy efficiency, energy savings and energy management including a technological description of the operating and dimensioning principles.
Energy Systems and Environment	This course assesses current and potential future energy systems, covers resources, extraction, conversion, and end-use, and emphasizes meeting regional and global energy needs in the 21st century in a sustainable manner. Different renewable and conventional energy technologies will be presented including biomass energy, geothermal energy, wind power, solar energy, hydrogen fuel and their attributes described within a framework that aids in evaluation and analysis of energy technology systems in the context of environmental goals.
Experimental and Numerical Advanced Design	This course aims at delivering the skills to perform finite elements simulations of mechanical problems including aspects of nonlinearity, structural integrity and dynanics, which are the most advanced topics of modern mechanical design. A special 30 hours module about thermal methods for fatigue asessment is also provided for practicing about fatigue and design procedures of structures under cyclical loads. Laboratory activity and modeling/analysis exercitations will be organized throughout the course for training the students in gathering the proper material data for their simulations and for checking the accuracy of their finite elements analyses.
Fluid Machines Design	The course is divided into two parts. The first part of the course concerns the design of wind turbines, while the second is devoted to the study of reciprocating internal combustion engines. The course provides the basis for the aerodynamic design of wind turbines (horizontal and vertical axis wind turbines) and the evaluation of their performance. With regard to reciprocating internal combustion engines (ICE) the course provides students with the basis for the design, focusing on key aspects such as Performance Optimization, Engine Cycle Simulation, ICE Combustion, Pollutant Formation and Control. During the course will be carried out numerical simulations on the computer.

Fluid Mechanics		The course has the main objective of providing the basic knowledge of Fluid Mechanics. After a preliminary part in which the physical characteristics of fluids are described, the course includes the introduction of the main topics of Fluid Mechanics, accompanied by the necessary theoretical framework. The topics covered are: Hydrostatics, Kinematics and Dynamics. The lessons on Hydrostatics aim to provide the skills for solving problems relating to pressure measurements and the evaluation of thrusts on surfaces. The kinematics lessons provide the necessary tools to describe the movement of fluids and the constraints to which this movement must be subjected. Then, the concepts of Eulerian and Lagrangian quantities and the principle of conservation of mass are introduced. In the chapter of Dynamics, after the description of the fundamental principles of conservation of momentum and energy, the applications are mainly aimed at solving problems related to confined flows in conditions of steady motion. The course foresees that about 40% of the time will be dedicated to classroom exercises, related to the solution of practical problems of Fluid Mechanics.
Machine Design		The course aims to train master student engineers developing their skills acquired in the previous courses of Applied Mechanics and Materials Strength in order to apply them on the design of mechanical components to assure their resistance and verify their availability to the purposed functions. Starting from the basis of the design of mechanical components and systems, the components are characterized both in the static and dynamical field, with regard to the fatigue behaviour. The acquired method will allow to carry out a project of a simple mechanical system, in which the rules of the mechanical design will be applied.
Machine Design II		This course is aimed at delivering the main concepts of finite elements and of structural dynamics in the design of engines, machines and their mechanical components. The familiarization with modeling issues is also promoted, together with the implementation of the above concepts to practical cases. Class exercises will be organized for practising with both self-written computer programs as well as commercial f.e. codes.
Mechanical and Thermal Measurements		The course aims to provide basic measurement knowledge and an accurate transducers analysis. Both static and dynamic analysis of the performance of the measurement chains will be addressed. The main types of transducers are analyzed in detail with the discussion of the metrological parameters. The engineering student will be instructed on the most significant aspects of measurement devices and methods for detecting the main mechanical and thermal quantities. The course also includes practical exercises in the classroom and in the laboratory with examples of the use of sensors and data analysis.
Mechatronics		The Mechatronics course provides students with a transversal training on scientific and technical aspects that characterize mechatronic systems, as they are based on electronics, computer science, mechanics and automatic controls. The course is divided into two parts: the first part concerns the study of digital logic, electronic, hydraulic and pneumatic components, and the basics of microcontroller programming. The second part is on the study of kinematics and dynamics of mechanical and robotic systems. During the course, various computer numerical exercises will be carried out.
Materials Science and Technology (2 sub-courses)	1 - Macromolecular Chemistry	The course aims to provide the student with the notions relating to the relationships between the structure of polymeric materials and their mechanical properties, their transformation technologies and the problems relating to their production. It is also intended to provide foundations on polymer matrix composites.
	2 - Materials Science and Technology	The aim of the course is to introduce the fundamental concepts related to: structure of metal and ceramic materials, structure-property relationships and some of the most important technological transformation processes. In the Materials Science and Technology module, metal and ceramic materials will be addressed in detail by focusing on the properties of engineering interest for a mechanical engineer. Finally, material recycling issues and Life Cycle Analysis (LCA) techniques will be shortly addressed. An introduction of the recent additive manufacturing technologies will be provided in the final part of the module. The student, by the end of the course, must be able to classify the different engineering materials, their properties in relation to their structure and the typical applications for each material.

Manufacturing Process Technology	The aim of the course is to provide an overview of the main manufacturing processes in industrial engineering. The fundamental principles of manufacturing processes are discussed, also with the intent of providing some concepts about the relationships between these processes and product requirements, in terms of performance and cost. The main issues concerning material behaviour of metals, bulk and sheet metalworking, metal machining and metal casting are discussed in this course. Moreover, an introduction on statistical quality control and their use in the manufacturing field will be introduced. During the course, the students will acquire the main theoretical knowledge, related to both scientific and technological aspects, relevant to the manufacturing industrial activities.
Non-Destructive Evaluation on mechanical elements	The course aims to provide basic knowledge on the damages that can be generated in the phase of building and during operation, as well as on methods for non-destructive evaluation of these damages.
Modeling and Simulation of Mechanical Systems	The main aim is bringing students to create numerical models suitable to simulate dynamics of complex mechanical systems, both in time and frequency domain, thus studying stability to applied force fields. Fundamental techniques of discretization of mechanical systems will be provided and specific numerical codes (Matlab ®, Simulink ®) will be used to solve equations of motion.
Thermal Systems	The course aims to provide students with the know-how and expertises finalized to the design of heating and air conditioning systems. It also outlines the dimensioning principles of the fundamental components: air admittance valves, air distribution networks, Air Handling Units, heat admittance terminals, water distribution networks, heat generators and refrigeration machines.