Syllabus

Course Description

Course Title	Thermo-Mechanical Measurements
Course Code	47592
Course Title Additional	
Scientific-Disciplinary Sector	IIND-07/A
Language	English
Degree Course	Master in Industrial Mechanical Engineering
Other Degree Courses (Loaned)	
Lecturers	Prof. Francesco Patuzzi, Francesco.Patuzzi@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/30127 Prof. Franco Concli, Franco.Concli@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/34279
Teaching Assistant	Dott. Lorenzo Pagliari
Semester	Second semester
Course Year/s	1
CP	5
Teaching Hours	24
Lab Hours	24
Individual Study Hours	79
Planned Office Hours	
Contents Summary	The course specifically deals with the fundamental concepts of thermomechanical measuring systems, integrates and complements topics of thermodynamics, heat transfer and mechanics introduced in previous elective courses and supplies some tools useful for the implementation of measuring systems in thermomechanical applications.

	The course consists of a single module of 24 hours of frontal lectures and 24 hours of exercises and is composed by three main parts, the first one mainly dealing with the fundamentals of measuring systems, the second one with thermal measurements and the third one with mechanical measurements. The lectures in the first part of the course introduce the fundamentals of measuring systems, by presenting and discussing the general principles of metrology and the definition of an internationally recognized system of units. Proper terms and definitions will be introduced, as well as the concepts of accuracy and precision of a measure, the uncertainty associated with a measure and the propagation of the uncertainty along a measuring chain. Emphasis will be given in the second part of the course on thermal measurements, presenting the typical temperature sensors used in the industry: thermocouples and resistance temperature detectors. Particular care will be given to the role of calibration, also from a practical perspective. Elements will be finally provided on temperature measurements through optical methods and on thermal analysis. The third part of the course will be devoted to mechanical measurements, with a peculiar focus on the measurement of the strain of a mechanical component. A description of the working principle of strain gauges will be provided, as well as the use of Wheatstone bridge for the compensation of external effects. Theoretical topics will be supplemented by practical activities, preferably carried out in the laboratories of the faculty. Exercises proposed during the course will consist in solving practical problems with the aim of giving the students a deeper comprehension and understanding of the topics.
Course Topics	The first part of the course will cover the following topics: • Introduction to the principles of measurement systems: measuring chains, accuracy, precision • Review on unit of measurements and conversion • Uncertainty of a measure and uncertainty propagation The second part of the course (thermal measurements) will cover

	the following topics: • Temperature sensors: international scale of temperature, thermocouples, resistance sensors • Calibration of temperature sensors • Elements of optical methods and thermal analysis The third part of the course (mechanical measurements) will cover the following topics: • Introduction to mechanical measures • Strain gauges: working principle of the sensors • Wheatstone bridge: compensation of external effects.
Keywords	Measurement systems, thermal measurements, mechanical measurements
Recommended Prerequisites	
Propaedeutic Courses	
Teaching Format	The course consists of lectures in which the topics are presented by the lecturers. There are also classes (exercises and laboratories) that will give practical examples of the application of theoretical topics. Course topics will be presented on the blackboard and using electronic slides. Teaching material and additional materials will be provided by the lecturers during the semester.
Mandatory Attendance	Recommended
Specific Educational Objectives and Learning Outcomes	Through the study and the application of the topics presented during the lessons, students should acquire: 1) the knowledge and understanding of the fundamentals principles of thermomechanical measuring systems 2) the ability of applying knowledge and understanding of the theoretical principles to the analysis of thermomechanical measuring systems 3) the ability to make autonomous judgements in the assessment of accuracy and precision of measurement instrumentation and uncertainty of a performed measurement 4) communication skills to correctly and properly present the concepts acquired in the course and to solve simple application problems regarding thermomechanical measurements 5) lifelong learning skills through the possession of the tools for the acquisition of technical information on measuring systems and

	to update knowledge.
Specific Educational Objectives and Learning Outcomes (additional info.)	
Assessment	Formative assessment In class and laboratory exercises and activities (2,3,4,5) Summative assessment Examination of the course is carried out by means of a written exam. The written examination includes questions to assess the knowledge and understanding of the course topics and questions designed to assess the ability to transfer these skills to case studies and practical applications (1,2,3,4) Questions on practical applications also assess the ability of the student to apply the knowledge and understanding of the course topics, the ability to make judgments and finally, the student communication skills (1-5).
Evaluation Criteria	It is relevant for the assessment of the written exam to master the specific language (also with respect to teaching language); prove the understanding of the topics and learning skills; evaluate and establish relationships between topics; grow specific skills in critical thinking. Regarding the practical applications, it is relevant to clearly describe suitable technical solutions and be able to make critical judgments and apply the theoretical concepts.
Required Readings	*Didactic materials will be provided by the professor during the course.* *There is no single textbook that covers the entire course. The course material is collected from various sources that will be announced during the course.* *Some relevant sources are:* - *Ernest O. Doebelin, Measurement systems: application and design, Mcgraw-Hill* - *J. V. Nicholas, D. R. White, Traceable Temperatures: An Introduction to Temperature Measurement and Calibration, Wiley.*
Supplementary Readings	

Further Information	
Sustainable Development Goals (SDGs)	Quality education, Industry, innovation and infrastructure, Decent work and economic growth