UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2021/2022
BACHELOR'S DEGREE (BSC)	ENERGY ENGINEERING AND RENEWABLE ENERGIES
SUBJECT	THERMAL TECHNIQUE EQUIPMENT AND MEASUREMENTS
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50302-Ingegneria meccanica
CODE	18112
SCIENTIFIC SECTOR(S)	ING-IND/12
HEAD PROFESSOR(S)	D'ACQUISTO LEONARDO Professore Ordinario Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	96
COURSE ACTIVITY (Hrs)	54
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	3
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**D'ACQUISTO LEONARDO** Thursday 08:30 10:00 Edificio 8 - stanza docente

DOCENTE: Prof. LEONARDO D'ACQUISTO

PREREQUISITES	General concepts of mathematical analysis (calculus of derivatives and integrals), General concepts of phisycs (knowledge of main physical quantities, measurement units' systems) . Basic principles of electrotechnology (resistive, inductive and capacitive circuits).
LEARNING OUTCOMES	D.1: KNOWLEDGE AND UNDERSTANDING The course aims at the acquisition of knowledge of the operating techniques of thermodynamic measurements and adjustments. The assessment of knowledge and understanding will be through a final examination during which the student will present the topics covered in the course and discuss the exercises performed. D.2: APPLYING KNOWLEDGE AND UNDERSTANDING The course allows the application of techniques for thermodynamic measurements and adjustments. To make more effective understanding of the theoretical, it will be carried out numerous exercises and experimental test after which the student can identify, understand and analyze the problems that may arise in testing , both in the laboratory and in the field , and will know ' give them solution. The student will be able to make thermodynamics and fluid dynamics measurements and adjustments. The evaluation of the knowledge and understanding gained by the student will be applied during the final exam, through the discussion of the exercises performed and laboratory test report. D.3: MAKING JUDGMENTS The course aims to achieve integration between the knowledge derived from the study of other disciplines, basic and vocational skills, included in the three-year degree course in Energy Engineering in order to allow you to manage, critically and independently, the related choices the complexity of measurements and adjustments of thermofluidodynamic parameter. The acquisition of autonomy of judgment on the part of the student will be verified during the final exam, by illustration criticism of the choices and comparing these with other possible options. D.4: COMMUNICATION SKILLS The course allows to develop the ability to communicate clearly the reasons of operational choices made and their connection with the underlying theoretical knowledge. Such skills will be exercised during the hours of exercise, through exposure and discussion of the choices made by students. The acquisition of communication skills of the student will be verified during the final exam, including through the illustration of exercises and experimental test performed. D.5: LEARNING SKILLS The course aims to develop the learning skills to help deal with the independent professional activity. This capacity will be developed urging the student to draw independently from theoretical sources and information, other than those proposed during the course, drawing on texts, regulations, laws, websites, scientific articles, etc. The ability to learn will be verified in the final examination during which the student will demonstrate the achieved awareness and critical capacity of analysis and synthesis of theoretical and applied aspects of the discipline studied.
ASSESSMENT METHODS	EXAMS OUTLINE Oral exam and laboratory report discussion. The oral exam and laboratory report discussion is a talk with essay questions on the whole course programme. Oral exam looks at: - knowledge and understanding of the course programme; applying such skills for problem solving within the course or related contexts; - correct use of language, clearness, fluency; concepts reinterpretation, critical faculties, and connection skills in disciplinary or interdisciplinary contexts. Marks are out of 30. Minimum mark is 18/30. ASSESSMENT CRITERIA For oral exam, marks are awarded considering to what extent the student has achieved the learning outcomes. The following scheme can be assumed for reference (see learning outcomes section, descriptors D.1-D.5). Best fit applies when learning outcomes are met at different levels. 28-30 / 30 with distinction D.1/D.2: full contents mastery; no errors; self-corrections/integrations of inaccuracies/omissions; correct and rigorous approach to problems; correct, complete and effective solutions; some originality evidence D.3/D.4/D.5: effective concepts reworking, coherent and autonomous approaches and judgments, disciplinary/interdisciplinary connections; very clear presentation, structured arguments, correct use of language. 24-27 D.1/D.2: good knowledge and understanding of course contents; few minor errors, partially fostered self-corrections or integrations; good approach to problems, essentially correct solutions;

	D.3/D.4/D.5: good coherence in linking concepts and approaching disciplinary or related subjects; good presentation, adequate use of language. 18-23 D.1/D.2: sufficient knowledge of contents; feasible approach to problems although with limited autonomy, acceptable solutions; errors or omissions not serious; D.3/D.4/D.5: sufficient concepts links within disciplinary contexts, although tentative and guided; basic presentation and use of language. below 18 (mark not awarded) D.1-D.5: learning outcomes are not sufficiently met.
EDUCATIONAL OBJECTIVES	The aim of the course is to provide students a theoretical and practical knowledge of the equipment and technology in the field of fluid dynamics and heat engineering measures and adjustments. They will learn all the usual problems that require the determination of measures in the heating energy sector, with nods to the theory of errors. Specific attention will be given to know how to objectively assess: the accuracy, response time and other characteristics of employed instrumentation.
TEACHING METHODS	Lectures, exercises and laboratory activities. Teaching activities are organized to help the achievement learning outcomes (see learning outcomes section, descriptors D.1-D.5). The course contents are offered through lectures and guided exercises and laboratory activities, emphasizing the applications and the synergy between the different topics (D.1). During the course, the contents are applied to problem solving issues, thus stimulating the development of the ability to apply the acquired knowledge and skills (D.2). During lectures (partly carried out through dialogues and interactions with students) and exercises, students are fostered to critically analyze the proposed issues; this helps the development of students analytical abilities and autonomous judgment (D.3). At the same time, the dialogue and interaction opportunities foster students to improve their skills of communication, argumentation and use of language (D.4). Finally, all course activities contribute to the development of learning skills, through knowledge reworking, links to real and interdisciplinary applications and stimulus in facing new problems autonomously (D.5).
SUGGESTED BIBLIOGRAPHY	1. Dispense del corso 2. Doebelin Ernest O., “Strumenti e metodi di misura”, 2 ed., (curr. Cigada A., Gasparetto M.), 2008, Mc Graw-Hill 3. Cascetta F, Vigo P., “Introduzione alla metrologia. Note delle lezioni di Misure termotecniche”, 1989, Liguori

SYLLABUS

Hrs	Frontal teaching
20	Basics of measurements, instruments and measuring systems. Analytical models of instruments' dynamic response - Introduction to the evolution of the most widespread systems of measurement units. International system of measurement units and reference standards - Types of measuring instrument applications: Observation of processes and operations - Regulation of processes and operations - Experimental investigation in engineering - General configuration and operating principles of the measuring instruments: functional elements of an instrument - Active and passive sensors - Analogical or numerical operating method - Compensation or direct reading instruments - Input and output quantities of an instrument - Methods for reducing the effects of influencing quantities. - Generalized operating characteristics of measuring instruments and systems 1 - Static characteristics - Measurand, instrument, operator, environment. Resolution. Stability. Interaction with the environment. Repeatability, the limit of the potential of a measurement system. Reproducibility, a concrete assessment of the potential of a measurement system (outline). Accuracy, need for a reference sample. The calibration of an instrument. The traceability of measuring instruments to national standards. Measurement compatibility. Typical errors: linearity, hysteresis, inversion, mobility, mobility threshold. Calibration - Repeatability - Accuracy - Systematic error - Sensitivity - Linearity - Threshold value - Resolution - Hysteresis - Dead space - Scale readability - Useful range - Input impedance - Effect of applying the instrument on the quantity to be measured 2 -Dynamic features: Generalized mathematical model of a measurement system - Transfer function - Zero, first and second order systems and their behavior in the presence of variable input quantities according to step, ramp, impulsive and sinusoidal functions - Graphical representation of the dynamic characteristics of a system 3 - Introduction to harmonic analysis - Characterization of stochastic signals and their applications in the analysis of the response of a system - Conditions necessary for the faithful reproduction of signals - Experimental determination of the characteristic parameters of a measurement system.

SYLLABUS

Hrs	Frontal teaching
20	General principles on the measures; The International System of Measures and other systems; Theory of the errors; Methods of signal processing; Registration data and Data Logger; automatic systems for acquisition and data processing; video-photographic methods. Pressure measurements: Primary conversion elements - Diaphragm pressure gauges - Electric vacuum gauges - Temperature measurements: Mechanical thermometers - Thermocouples - Resistance thermometers - Thermistors - Pyrometers. Use of Plank's law. Total irradiation pyrometers. Monochrome lamp pyrometers. - Measurements at room temperature with infrared systems within the infrared field. - Anemometers; Measurements of speed in fluid densities' constant or variable; Hot wire anemometry; Fluid velocimetry; volumetric meters; Diaphragms, nozzles, and venturi flowmeters; Calibration and regulation of flow meters; Industrial calorimetry; Measurement of specific heats; Measuring the steam quality; Measurements of conductivity on thermal conductive materials; Measurements of conductivity on thermal insulation materials and construction; Measurements the calorific value. Humidity; Psychrometers; hygrometers; Criteria for installation and use; hygrometric recorders; Equipment for combustion control; measurements in combustion plants; Equipment for surveying and recording produced by combustion.
5	Elements of statistics and uncertainty evaluation with applications to practical cases of uncertainty evaluation procedures

Hrs	Practice
6	Elements of statistics and uncertainty evaluation with applications to practical cases of uncertainty evaluation procedures
3	Measurements of experimental data and evaluations