UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2018/2019
BACHELOR'S DEGREE (BSC)	INGEGNERIA CIBERNETICA
SUBJECT	MEASURES AND EQUIPMENT FOR AUTOMATION
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50291-Ingegneria della sicurezza e protezione dell'informazione
CODE	17879
SCIENTIFIC SECTOR(S)	ING-INF/07
HEAD PROFESSOR(S)	COSENTINO VALENTINA Professore Ordinario Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	9
INDIVIDUAL STUDY (Hrs)	153
COURSE ACTIVITY (Hrs)	72
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	3
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**COSENTINO VALENTINA** Monday 10:00 17:00 In presenza / In person: Laboratorio didattico misure elettriche, Edifico 9, piano terra, stanza S09PT062 (ex U030) / Electrical measurement teaching lab, Building 9, ground floor, room S09PT062 (ex U030). A distanza / Remotely: Teams call. RICEVIMENTO PREVIO APPUNTAMENTO VIA EMAIL O CHAT TEAMS / APPOINTMENT IS NEEDED, BY EMAIL OR TEAMS CHAT Tuesday 10:00 17:00 In presenza / In person: Laboratorio didattico misure elettriche, Edifico 9, piano terra, stanza S09PT062 (ex U030) / Electrical measurement teaching lab, Building 9, ground floor, room S09PT062 (ex U030). A distanza / Remotely: Teams call. RICEVIMENTO PREVIO APPUNTAMENTO VIA EMAIL O CHAT TEAMS / APPOINTMENT IS NEEDED, BY EMAIL OR TEAMS CHAT Wednesday 10:00 17:00 In presenza / In person: Laboratorio didattico misure elettriche, Edifico 9, piano terra, stanza S09PT062 (ex U030) / Electrical measurement teaching lab, Building 9, ground floor, room S09PT062 (ex U030). A distanza / Remotely: Teams call. RICEVIMENTO PREVIO APPUNTAMENTO VIA EMAIL O CHAT TEAMS / APPOINTMENT IS NEEDED, BY EMAIL OR TEAMS CHAT Thursday 10:00 17:00 In presenza / In person: Laboratorio didattico misure elettriche, Edifico 9, piano terra, stanza S09PT062 (ex U030) / Electrical measurement teaching lab, Building 9, ground floor, room S09PT062 (ex U030). A distanza / Remotely: Teams call. RICEVIMENTO PREVIO APPUNTAMENTO VIA EMAIL O CHAT TEAMS / APPOINTMENT IS NEEDED, BY EMAIL OR TEAMS CHAT

DOCENTE: Prof.ssa VALENTINA COSENTINO

PREREQUISITES	Knowledge of electromagnetism, electrical components, electrical circuits (d.c. and a.c.)
LEARNING OUTCOMES	D.1: KNOWLEDGE AND UNDERSTANDING Students are expected to acquire knowledge and understanding basis concerning: fundamentals of metrology and measurement theory; measurements methods, sensors and instrumentation, with a particular focus on applications in the automation field. D.2: APPLYING KNOWLEDGE AND UNDERSTANDING Students are expected to be able to work in laboratories, industrial and on-field contexts, being skilled for: choosing the most suitable instrumentation and method for the application under study; performing measurements with analog and digital instrumentation; evaluating measurement uncertainty; approaching measurement systems for automation. D.3: MAKING JUDGMENTS Students are expected to be able to collect and analyse measurement data and to approach problems and make judgements concerning the basic components of a measurement system, taking into account the technical specifications and requirements of the application being studied. D.4: COMMUNICATION SKILLS Students are expected to communicate their knowledge, analysis and conclusions concerning the approach, definition and development of a measurement process, both in general applications and, particularly, in the automation field. In doing this, students are expected to address both specialist and non-specialist audiences, with clearness and correct use of language, both in oral dialogues and through written technical reports. D.5: LEARNING SKILLS Students are expected to develop methodological skills and abilities of connection and reworking of knowledge about measurement and instrumentation in automation contexts. Thanks to this, students will be able to carry out further studies or professional activities with a high degree of autonomy, in those areas where knowledge and skills gained can be helpfully applied.
ASSESSMENT METHODS	EXAMS OUTLINE Practical test and oral exam; submission of written technical reports on laboratory exercises carried out during the course. Practical test consists of carrying out and discussing one laboratory exercise. The test exercise is chosen by the Professor among those carried out during the course. The oral exam is a discussion with essay questions on the whole course programme, including the laboratory exercises and the related written reports. Oral exam is right after the practical test. Tests minimum duration is 30 minutes. The 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 and fluency, both in oral presentation and writing style; concepts reinterpretation, critical faculties, and connection skills in disciplinary or related contexts. Marks are out of 30. Minimum mark for passing the exam: 18/30. ASSESSMENT CRITERIA Mark is awarded considering the whole exam (practice, oral, written reports) and evaluating 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. 29-30 / 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, connections in disciplinary and broader related contexts; very clear presentation, structured arguments, correct use of language. 24-28

	D.1/D.2: good knowledge and understanding of course contents; 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; acceptable 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 course is aimed to give students knowledge, understanding skills and abilities for facing issues related to the measurement of electrical and non electrical quantities in the automation field. For this purpose the course gives knowledge and basic skills concerning: general principles of metrology and measurement theory; main measurement methods, instruments and systems; measurement uncertainty evaluation; sensors and instrumentation for automation. Thanks to this, at the end of the course students will be able to develop and manage a measurement process, properly selecting and using measurement instruments, methods and procedures, taking into account the specific problem under study and the required performances and technical specifications.
TEACHING METHODS	Lectures; classroom and laboratory exercises, case studies analysis. 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 emphasizing the applications and the synergy between the different topics (D.1). During the course, the contents are applied to problem solving issues and case studies analysis, thus stimulating the development of the ability to apply the acquired knowledge and skills (D.2). During both lectures (partly carried out through dialogues and interactions among students and teacher) and classroom and laboratory 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	Dispense del corso fornite dal docente / Lecturer course slides Altro materiale utile, di consultazione / Other useful reference material: A.Carullo, U. Pisani, A.Vallan “Fondamenti di Misure e Strumentazione Elettronica” CLUT Editrice, 2006. Keithley Instruments “Data Acquisition and Control Handbook” (www.keithley.com) Measurement and Computing “Data Acquisition Handbook”, www.mccdaq.com A. Martin, “Strumentazione e tecnologie di misura”, Ed. delfino, 2016

SYLLABUS

Hrs	Frontal teaching
6	Metrology and measurement theory fundamentals. Measurement definition and scopes. Measurements for automation. Physical-to-electrical quantities conversion, measurements of electrical quantities. Measurement logical scheme an execution. Measurement result. Direct and indirect measurements. Measurement traceability. Metrology fundamentals and terminology. International system of Units and measurement standards. Measurement uncertainty evaluation. Measurements compatibility.
14	Measurement instruments: Types, operating principles and features. General scheme of a measurement instrument. Metrological characteristics. Instruments classification (with respect to measurand). Voltmeters, ammeters, wattmeters, frequency meters, resistance/inductance meters. Multiple range meters, multimeters. Electromechanical instruments (basics). Main characteristics, types and features. Introduction to electronic instrumentation.General schemes and concepts. Measurement amplifiers. DC voltmeters, AC voltmeters. RMS/DC and TRMS/DC converters. Digital electronic instrumentation. Numeric counter (frequency, period). Numeric voltmeters and related AD converters. Digital Multimeters. Sampling instruments. Sampling theorem. Digital oscilloscope.

SYLLABUS

Hrs	Frontal teaching
14	Measurements on steady state circuits. DC measurement methods. Metering section. Measurements on two-pole elements. Resistance measurement (small, medium and high value). Ammeter-voltmeter methods. Instruments errors and correction. AC measurement methods. Power, inductance, capacitance measurements. Null measurement methods (d.c. and a.c.). Measurement sensitivity. Balance condition (d.c. and a.c.). Substitution methods. Measurement bridges. DC bridges. Wheatstone bridge and its applications. Unbalanced Wheatstone bridge. AC bridges. Classification. Quotient and product bridges. Potentiometers methods.
14	Measurement systems for automation. Fields of application. Automatic measurement systems. Distributed measurement systems. Measurement chain. Sensors and transducers. Classification and operating principles. Sensors and transducers for electrical and non electrical quantities. Signal conditioning. Communication and interface systems for sensors and instrumentation. Data acquisition systems and signal processing.

Hrs	Practice
9	Measurements with ammeter-voltmeter methods, Wheatstone bridge, potentiometers. Measurement uncertainty evaluation.
9	Measurements with digital instrumentation (multimeters, oscilloscopes, numeric counters). Measurement uncertainty evaluation.
6	Automatic measurement systems examples: choice and sizing of measurement chain elements.