UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2023/2024
MASTER'S DEGREE (MSC)	ELECTRONICS AND TELECOMMUNICATIONS ENGINEERING (FULLY ONLINE)
SUBJECT	AUTOMATIC MEASUREMENT SYSTEMS
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50364-Ingegneria elettronica
CODE	21518
SCIENTIFIC SECTOR(S)	ING-INF/07
HEAD PROFESSOR(S)	ARTALE GIOVANNI Ricercatore a tempo determinato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	9
INDIVIDUAL STUDY (Hrs)	162
COURSE ACTIVITY (Hrs)	63
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	1
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**ARTALE GIOVANNI** Monday 09:00 11:00 Electric and electronical measurement laboratory Wednesday 09:00 11:00 Electric and electronical measurement laboratory

DOCENTE: Prof. GIOVANNI ARTALE

PREREQUISITES	Electrotechnics, electronic and electric and electronic measurements knowledge
LEARNING OUTCOMES	D.1: KNOWLEDGE AND UNDERSTANDING Students are expected to acquire knowledge and understanding basis concerning: data acquisition board,PC-based instruments, digital signa processingi, virtual instruments, frequency analysisi, analog and digital spectral analyser. D.2: APPLYING KNOWLEDGE AND UNDERSTANDING Students are expected to apply their knowledge and understanding skills in order to be able to realise automatic measurement systems and virtal instruments for the analysis in the time and frequency domain. D.3: MAKING JUDGMENTS Students are expected to integrate their knowledge and increase their critical faculties for approaching problems and making judgements concerning the choice of the basic components of a measurement system, starting from the available information, components technical specifications and requirements of the applications being studied. D.4: COMMUNICATION SKILLS Students are expected to clearly communicate their knowledge, analysis and conclusions on electrical and electronics instrumentation and measurement methods of the principal electrical parameters . In doing this, students are expected to address both specialist and non-specialist audiences, with correct use of language. D.5: LEARNING SKILLS Students are expected to develop methodological skills and abilities of connection and reworking of knowledge about electrical and electronic measurements and related interdisciplinary 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 Oral exam. The oral exam consists of an interview, with open-ended questions on the entire program and on the course exercises. 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 for passing test: 18/30. ASSESSMENT CRITERIA For oral test, mark is 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	Know the main characteristics and types of automatic measurement systems, as well as the essential criteria for their implementation and operation, with special emphasis on those based on PCs and data acquisition cards. Know the basic principles of analog-to-digital conversion and signal acquisition and processing. Learn how to choose the most suitable hardware for both measurement and system characterization. Know the operating principle of an analog spectrum analyzer and be able to identify the main differences with similar digital devices.
TEACHING METHODS	Lectures
SUGGESTED BIBLIOGRAPHY	Dispense del corso fornite dal docente / Lecturer course slides Materiale di consultazione utile / Useful reference material: NI Tutorials, white papers e datasheets (www.ni.com) Keithley Instruments handbook “Understanding New Developments in Data Acquisition, Measurement, and Control” (www.keithley.com) Measurement and Computing “Data Acquisition Handbook” (www.mccdaq.com)

SYLLABUS

Hrs	Frontal teaching
10	Automatic measurement systems (AMS). Automatic systems for the measurement of a physical quantity. Types of AMS, general principles, architecture of base. Measurement chain, elements of a AMS. RTU, SCADA, IED, PLC.
10	Wet and dry contacts, Electromechanical relays, linear systems and Fourier transforms, systematic and random errors, LSB, ground loops, isolation, crosstalk, CMRR, configurations with acquisition boards. Temperature sensors (RTDs).
10	Sampling, ADC, ADC characteristics, jitter, filters, quantization, coding, interchannel delay, SNR, dithering.
8	ADC errors: nonlinearity, gain, DNL, offset, missing code, THD, ENOB, SINAD, DAQ.
3	Slow analog-to-digital converters: integral, single slope, dual slope, multi slope, sigma delta.
2	DACs and fast ADCs: SAR, Flash
8	MCU, DSP, CPU, frequency analysis, harmonics of a stationary and periodic signal, the transient, Nyquist frequency, FFT, DFT, leakage, scallop loss, synchronous and asynchronous sampling, window functions, harmonic interference
8	Analog and digital spectrum analyzer, block diagram, intermediate frequency, image frequencies, sweep time, resolution bandwidth, envelope detector, video filter, up and down conversion.
2	AM, FM modulations, Bessel functions
2	Ideal and real passive devices: resistance, capacitance and inductance.