UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2023/2024
BACHELOR'S DEGREE (BSC)	BIOMEDICAL ENGINEERING
SUBJECT	BIOMEDICAL EQUIPMENT
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50296-Ingegneria biomedica
CODE	23175
SCIENTIFIC SECTOR(S)	ING-INF/06
HEAD PROFESSOR(S)	MACALUSO ROBERTO Professore Associato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	96
COURSE ACTIVITY (Hrs)	54
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	3
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**MACALUSO ROBERTO** Tuesday 13:00 15:00 DEIM

DOCENTE: Prof. ROBERTO MACALUSO

PREREQUISITES	In order to attend proficiently the course, the student must posses a wide knowledge of Electronics, Physics and Chemistry.
LEARNING OUTCOMES	Knowledge and understanding At the end of the course the student will have mastery of sensors and related technologies to measure physical quantities of biomedical interest, and will acquire general knowledge on: a) physical phenomena related to transduction; b) semiconductor technologies for the realization of sensors; c) static and dynamic characteristics of sensing systems; d) transduction platforms in detection systems; e) design and use of the main devices for measuring biomedical signals; f) knowledge of the main medical instrumentation. Ability to apply knowledge and understanding The student will be able to apply his/her general knowledge on sensors and biomedical signal measurement systems to be a good designer, selector and user of sensor devices. He will also be able to apply signal conditioning techniques, as well as those of conversion into digital form to facilitate archiving, transmission or digital processing. He will finally be able to prepare the use of biomedical instrumentation for the acquisition of the main vital signs, knowing the principles and the main characteristics of the critical elements. Autonomy of judgment The student will be able to interpret the specifications of sensors and measurement systems; will be able to evaluate the data necessary for the evaluation of the performances and to interpret the judgments of the evaluation; finally, it will be able to collect the data necessary for the development of tools for measuring the most common physiological parameters. Communicative ability The student will acquire the ability to communicate and express problems concerning the subject of the course. He will be able to support conversations on issues concerning sensors, the technology used for their production and the biomedical instrumentation that uses them, highlighting the problems related to the limits, thus offering solutions. Learning skills The student will have learned the introductory concepts to the biomedical instrumentation which can be proficiently used in specific application sectors of the industrial and clinical Biomedical Engineering, as well as in the specialized courses that will follow during the Master Degree.
ASSESSMENT METHODS	The purpose of the evaluation is to ascertain that the student has full mastery of all the topics covered during the course. The evaluation will be based on a written test, which will consist of both exercises and questions on the various topics of the course. The questions proposed to the student will tend to verify that the student possesses adequate presentation skills, is able to correlate the various contents of the course on his/her own, understands the applications or the implications of the various contents covered in the discipline, has acquired adequate language properties, especially with reference to English technical terminology. The assessment is out of thirty (maximum mark: 30/30). The pass mark will be reached when the student will show, at least in general terms, knowledge and understanding of the topics, and minimal application skills for the resolution of specific cases. The student must also posses presentation and argumentative skills that enable the transmission of his knowledge to the examiner. Below this threshold, the examination will result insufficient. More in details, the assessment will be based on the following scheme: 30-30 cum laude: Excellent. Full knowledge and understanding of concepts and methods of the discipline, excellent analytical skills even in solving original problems; excellent communication and learning skills; excellent ability to connect the various topics discussed during the course. 27-29: Very good. Very good knowledge and understanding of concepts and methods of the discipline; very good communication skills; the student is able to apply his/her knowledge to solve the proposed problems and to range comfortably between one subject and another. 24-26: Good. Good knowledge of main concepts and methods of the discipline; discrete communication skills; limited autonomy for applying concepts and methods for solving original problems; limited ability to link the various topics dealt with during the course. 21-23: Satisfactory. Partial knowledge of main concepts and methods of the discipline; satisfactory communication skills; scarce judgment autonomy.

	18-20: Acceptable: Minimal knowledge of concepts and methods of the discipline; minimal communication skills; very poor or null judgement autonomy. Unacceptable: Insufficient knowledge and understanding of concepts and methods of the discipline.
EDUCATIONAL OBJECTIVES	The aim of the course is to provide the basic knowledge relating to the methods and typical problems of biopotential sampling and to the operating principles of the main diagnostic electromedical equipment. Together with the characteristics of the main biomedical signals and the modalities of their detection, an overview of the sensing phenomena and their implementation in the most common biomedical devices for the measurement of biosignals is provided. In addition, the course includes also both analysis and design of signal conditioning, amplification and digitalisation circuits and propose some examples of biomedical instrumentation aimed at training the student to understand how modern biomedical equipments allow the functional evaluation of the main physiological districts that make up the human organism . The course includes theoretical exercises. At the end of the course, students will be able to understand when a sensor works, which technologies are used to make sensors, what are the problems that limit the use of sensors in measurements, how to select sensors in specific applications, how to use the biomedical instrumentation for the physiological and clinical evaluation of some fundamental apparatuses of the human body.
TEACHING METHODS	Frontal lectures, numerical exercises, seminars.
SUGGESTED BIBLIOGRAPHY	Testi di riferimento/Reference texts: - J.G. Webster: Medical Instrumentation: Application and Design, John Wiley & Sons. ISBN: 978-1-119-45733-6 - Pallas-Areny, Webster: Sensors and signal conditioning. 2nd ed. John Wiley &Sons, 2001. ISBN: 978-0-471-33232-9 - G Avanzolini, E Magosso: Strumentazione biomedica. Progetto e impiego dei sistemi di misura, Patron Editore, Bologna, 2015. ISBN: 8855532952 Materiale fornito dal docente reperibile attraverso il portale studenti dagli studenti iscritti al corso /Material (projected slides) provided by the professor and available through the student portal by students enrolled in the course.

SYLLABUS

Hrs	Frontal teaching
6	Introduction to biomedical measurement systems. Generalities and classification of biomedical signals. Measurement of biomedical signals. Examples of physiological systems and signals. Direct and indirect measurements. Invasive and non-invasive measures: examples. Components of a biomedical measurement system: sensors/transducers, signal conditioning, numerical processing of biological signals, actuators, user interface. Diagnostic technologies.
4	Generalities on Measurement Systems: architecture, functional description, measurement errors.
10	Fundamentals of sensors and physical phenomena of transduction. Pressure, temperature, position, light radiation sensors. Piezoelectric, piezoresistive, thermoelectric effects. Wire and semiconductor strain gauges. Thermoresistors, thermistors, thermocouples and related materials. Wheatstone bridge and its applications. Capacitive and magnetic sensors. Photodetectors: phototubes, photomultipliers, photoresistors, photodiodes. Sensor manufacturing technologies. Nanostructured materials for the realization of biomedical sensors.
8	Components of a biomedical measurement system: amplifiers and filters. Differential amplifier for biomedical instrumentation. Analog-to-digital and digital-to-analog converter. Effect of noises.
4	Blood pressure measurement
6	Electrocardiography and heart activity measurements
6	Oximetry and measurement of the oxygen saturation of the arterial blood hemoglobin.
4	Electroencephalography and measures of brain activity.

Hrs	Practice
6	Exercises on the various topics addressed during the course.