UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2024/2025
MASTER'S DEGREE (MSC)	BIOMEDICAL ENGINEERING
SUBJECT	BIOMEDICAL ELECTRONICS
TYPE OF EDUCATIONAL ACTIVITY	C
AMBIT	20909-Attivit Formative Affini o Integrative
CODE	23230
SCIENTIFIC SECTOR(S)	ING-INF/01
HEAD PROFESSOR(S)	CURCIO LUCIANO Ricercatore a tempo determinato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	96
COURSE ACTIVITY (Hrs)	54
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	2
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**CURCIO LUCIANO** Monday 15:00 17:00 Previo appuntamento via e-mail.

DOCENTE: Prof. LUCIANO CURCIO

PREREQUISITES	The course is self-consistent, although it is preferable to have a basic knowledge of electronics, biomedical sensors and equipment.
LEARNING OUTCOMES	KNOWLEDGE AND UNDERSTANDING The course aims to offer the student a basic preparation for the complete professional management (technical, technical-commercial assistance, user support) of medical equipment with a high technological content. The main objective of the module is to enable students to acquire the skills necessary to support the medical profession in the evaluation of the characteristics and in the use of technologically advanced diagnostic tools present in hospitals and bioengineering laboratories. To achieve this goal, the course includes: lectures; analysis and discussion of case studies; guided seminars and debates on research topics. To verify the objectives, the exam includes a written and an oral test on the topics of the program. APPLYING KNOWLEDGE The student will be able to autonomously read standards and scientific literature of the sector, moreover, be able to support the medical doctors in learning, evaluating characteristics and using technologically advanced diagnostic tools available today. The student will be able to organize and manage technical assistance laboratories for hospital or company electromedical instrumentation (suppliers); assist hospital management for the purchase of complex medical instruments (tender documents). To achieve this goal, the course includes lectures, guided exercises and independent exercises concerning the use of the instrumentation covered by the course. To verify this objective, the written and the oral exam will concern the technical evaluation, the detailed description of the equipment and its operating principle. AUTONOMY OF JUDGEMENT With the “Biomedical Electronics” module, the student will have acquired a methodology for analyzing problems, in order to carry out the management of hospital equipment and technological systems in general: technical and economic assessments (tender specifications), preliminary project reports, checks and testing of hospital systems and equipment of any technological level. To achieve this goal, the course includes lectures, guided exercises, as well as open discussions of case studies and debates on selected research topics. To verify this objective, the written exam and the oral exam are dedicated to the technical evaluation, the detailed description of the equipment and its operating principle. COMMUNICATION SKILLS The student will have to acquire the ability to rationally communicate her/his knowledge about the concepts and methods of the discipline, with a good level of clarity, fluency and correct use of technical language. In particular, she/he must be able to draw up preliminary design reports, know the checks and tests of hospital systems and equipment of any technological level, suitably justifying the technical-economic choices made in managing them. She/he will be able to deal with designers (engineers) and users (doctors, technicians) of any type of technologically advanced medical diagnostic tool. To achieve this goal, the course includes: lectures, presentations and classroom discussions of case studies and guided debates on research topics. To verify this objective, the exam includes a written exam and an oral exam in which the candidate will be able to highlight their communication skills and competences. LEARNING SKILLS The student will be able to independently deal with any problem related to the management and control (purchases, maintenance, training, etc.) of any complex hospital equipment or technological system. To achieve this goal, the course presents some teacher-led solutions of specific design problems, technical debates on emerging topics and the relevant literature. To verify the objective, the exam includes a written exam and an oral exam in which the student will be able to demonstrate the skills and knowledge acquired and the skills developed.
ASSESSMENT METHODS	EXAM ORGANIZATION The exam includes a written test and an oral test. The written test score is expressed in thirtieths (highest score 30/30 with honours). The minimum grade to pass the written test is 18/30. DESCRIPTION OF THE TESTS The written test includes some open questions on the operating principles, on the description of the technical characteristics of the instrument and on technical-

	economic evaluations of the hospital equipment or technological system studied. The test is devised to evaluate: - the knowledge and understanding levels in the assessment of characteristics and in the use of diagnostic tools; - the capability to independently deal with problems relating to the management and control (purchases, maintenance, application training, etc.) of hospital technological instruments and/or systems; - the ability to present, argue and analyze the choices made. The oral test consists of an interview and is devised to evaluate: - the knowledge and understanding of the topics about the course of study; - the ability to communicate knowledge, analyses and conclusions, with a good level of clarity, fluency and correct use of language; - the ability to reinterpret the concepts and interdisciplinary connections, showing evidence of autonomously undertaking further studies or professional activity. LEARNING OUTCOMES In order to provide the overall evaluation, the results achieved in the following course objectives will be assessed. Knowledge and understanding: Evaluation of knowledge, understanding and integration of principles, concepts, methods and techniques of the discipline. Applying knowledge: Evaluation of capabilities in applying theoretical and technical knowledge for tackling and solving problems; evaluation of the autonomy level and originality of proposed solutions. Making judgements: Evaluation of logical, analytical and critical abilities for reaching appropriate judgments and decisions, based on available information and data. Communication skills and learning skills: Evaluation of the ability to communicate knowledge, analysis and conclusions, with a good level of clarity, fluency and correct use of language. Evaluation of the capability of reinterpreting and making interdisciplinary connections, showing evidence for autonomously undertaking further studies or professional activity. GRADES 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. 27-29: Very good. Very good knowledge and understanding of concepts and methods of the discipline; very good communication skills; very good capability of concepts and methods applications. 24-26: Good. Good knowledge of main concepts and methods of the discipline; adequate communication skills; limited autonomy for applying concepts and methods for solving original problems. 21-23: Satisfactory. Partial knowledge of main concepts and methods of the discipline; satisfying 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. Non acceptable. Insufficient knowledge and understanding of concepts and methods of the discipline. The exam and the related evaluation will be the same for non-attending students. Compensatory tools and dispensatory measures will be guaranteed by the Disability and Neurodiversity Center - University of Palermo (Ce.N.Dis.) to students with disabilities and neurodiversity, based on specific needs and in implementation of current legislation.
EDUCATIONAL OBJECTIVES	The module allows to deepen the functional and technical electronic characteristics of the medical diagnostic equipment; this is done starting from the in-depth analysis of the operating principles and control circuitry of the most used transducers in medicine and from concepts and methods of measurement of the most significant physiological signals (ECG, EEG, EMG, evoked potentials, etc.), and developing, in the various lessons, the application, functional and circuit knowledge of the following medical equipment, here in order of complexity: physiological signal detection systems (electrocardiographs, polygraphs, electroencephalographs, myographs), diagnostic imaging systems (radiographic equipment, computerized axial tomography, ultrasound tomography and doppler velocimeters, NMR - nuclear magnetic resonance, PET - positron emission tomography, scintigraphs, angiographs), electrophysiological monitoring systems (for operating room, resuscitation unit, intensive cardiology care unit). A final section is dedicated to analogies, models and simulation of biological systems, with particular reference to the human organism and the ECG signal interpretation algorithms, more commonly used in the medical field. The main objective of the module is to provide the student with a basic preparation for the management (technical, technical-commercial service, user

	support) of high-tech medical equipment and to acquire skills to support the medical class in learning, evaluation of features and use of technologically advanced diagnostic tools (this is the activity of bioengineering laboratories, now foreseen in hospitals, where they will eventually be able to work as graduates). The module includes guided and autonomous exercises on the functioning and use of the instrumentation covered by the course; on technical-economic assessments (tender documents/specifications), on checks and tests of hospital systems and equipment preliminary design reports.
TEACHING METHODS	Teacher-led lessons and design examples; guided debates on case studies and emerging research topics.
SUGGESTED BIBLIOGRAPHY	Slides, dispense e materiale didattico fornito dal docente. Slides, handouts and teaching material provided by the teacher. Testi consigliati per consultazione e approfondimento: Recommended texts for consultation and further study: - The biomedical engineering handbook, 2nd Edition, Joseph D. Bronzino (Editor in chief); CRC Press in cooperation with IEEE Press, Boca Raton, FL 2000, Vol. I, ISBN 0-8493-0461-x, Vol. II, ISBN 0-8493-0462-8; - Dougherty, G. (2009). Digital Image Processing for Medical Applications. Cambridge: Cambridge University Press, ISBN-13 978-0-511-53343-3 eBook (EBL), ISBN-13 978-0-521-86085-7 hardback; - Smith N.B., Webb A. - Introduction to medical imaging_Physics, engineering and clinical applications, (2010), Cambridge Texts in Biomedical Engineering, ISBN: 9780521190657 (hardback), ISBN: 9780511760976 (digital); - Handbook of Biomedical Instrumentation – Technology and Applications, Second Edition, R S Khandpur, (2003), Tata McGraw-Hill Publishing Company Limited, ISBN: 978-0-07-177746-9; - J.G. Webster: Medical Instrumentation: Application and Design, John Wiley & Sons; 5th Edition, 2020. ISBN: 978-1-119-45733-6; - Norbert Leitgeb, Safety of Electromedical Devices, Law – Risks – opportunities, SpringerWienNewYork, (2010), ISBN 978-3-211-99682-9; - Lorenzo Rossano, Bioingegneria Elettronica, Modelli di Simulazione dei Sistemi Biomedici Vol. 1, Elettronica e Strumentazione Biomedica Vol. 2, Ed. McGraw-Hill, 2007, qualsiasi edizione a partire da (any edition since) 2007, ISBN: 8838664862; - Suresh R. Devasahayam, Signals and systems in biomedical engineering - Signal processing and physiological systems modeling, Springer, 3rd edition, 2019, ISBN: 9811335303; - Rangaraj, M. Rangayyan, Biomedical signal analysis - a case study approach, IEEE Press Series on Biomedical Engineering, John Wiley & Sons, edizioni a partire dal (any edition since) 2002, Print ISBN:9780471208112 |Online ISBN:9780470544204.

SYLLABUS

Hrs	Frontal teaching
2	Electricity and magnetism in histology: engineering approach of measurements on cell, nerve, muscle. Synaptic transmission. Electromechanical activity of the cardiovascular and respiratory systems. Filtering system of the renal system. Effects of electromagnetic fields on the electrical activity of cells: thermal, microscopic and macroscopic effects, microwave effects, some physical, mathematical and circuit investigation models.
2	Transducers: electronic circuits for measurement and control. Examples: electromechanical, potentiometric, strain gauges, capacitive, piezoelectric, magnetic, photoelectric; mathematical schemes (functions and transfer matrices). Measurement and control of physiological signals: translation, electronic manipulation, automatic interpretation of the corresponding signals.
4	Electromedical equipment: - electrocardiographs; - electroencephalographs.
4	Electromedical equipment: - polygraphs; - hemodynamic and angiographic investigations; espiratory and pressure curves relief.
6	Diagnostic imaging systems: - ultrasound; - Doppler velocimeters and flow meters.
6	Radiology: - traditional and digital equipments; - C.A.T. (Computerized axial tomography).
6	N.M.R. - Nuclear Magnetic Resonance.
4	Nuclear medicine: P.E.T. - positron emission tomography; scintigraph, gamma camera, angiograph (traditional, digital, to magnetic resonance); f.M.R.I. - functional magnetic resonance.
4	Analogies, models and simulation of biological systems. Systems approach to the study of organisms; systems in biology and systems in engineering; anatomical - functional schemes. Circuit analogies and behavioral simulators of simple and complex physiological systems. Most common application examples: cardiovascular, respiratory, digestive and renal apparatus, thermoregulation, neuromuscular, sensory and cerebral systems.

SYLLABUS

Hrs	Frontal teaching
2	Notes on hemodialysis machines, cardiac pacemakers, cardiac defibrillators, surgical instruments, and, laser applications in the biomedical field.
2	Design, development and application of in-silico systems for biosystem modeling and signal processing. Examples of mathematical models of the cardiovascular system: Windkessel, Guyton, Grodins and 'lumped-parameter' models.
2	Mathematical Aspects of Biomedical Electronic System Design. Notes on mathematical model regarding x-rays as waves and models in PET: Tracer Kinetic and General Compartmental Models.

Hrs	Practice
10	Guided and autonomous exercises on the functioning and use of the instrumentation covered by the course; on technical-economic assessments (tender documents/specifications), preliminary design reports, checks and tests of hospital systems and equipment.