UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Biomedicina, Neuroscienze e Diagnostica avanzata		
ACADEMIC YEAR	2022/2023		
MASTER'S DEGREE (MSC)	MEDICINE AND SURGERY		
INTEGRATED COURSE	BIOPHYSICS, BIOELECTRIC SIGNALS AND BIOMEDICAL DEVICES - INTEGRATED COURSE		
CODE	21835		
MODULES	Yes		
NUMBER OF MODULES	3		
SCIENTIFIC SECTOR(S)	BIO/09, ING-INF/06, ING-IND/34		
HEAD PROFESSOR(S)	LA CARRUBBA VINCENZO	Professore Associato	Univ. di PALERMO
OTHER PROFESSOR(S)	PERNICE RICCARDO	Ricercatore a tempo determinato	Univ. di PALERMO
	LA CARRUBBA VINCENZO	Professore Associato	Univ. di PALERMO
CREDITS	14		
PROPAEDEUTICAL SUBJECTS			
MUTUALIZATION			
YEAR	2		
TERM (SEMESTER)	2° semester		
ATTENDANCE	Mandatory		
EVALUATION	Out of 30		
TEACHER OFFICE HOURS	**LA CARRUBBA VINCENZO** Tuesday 11:00 12:00 Studio docente, edificio 6 secondo piano Thursday 11:00 12:00 Studio docente, edificio 6 secondo piano **PERNICE RICCARDO** Wednesday 08:00 10:00 Stanza 3001, terzo piano Ed. 9, oppure su Microsoft Teams, in entrambi i casi previa prenotazione tramite Portale Studenti Thursday 15:00 16:00 Stanza 3001, terzo piano Ed. 9, oppure su Microsoft Teams, in entrambi i casi previa prenotazione tramite Portale Studenti		

DOCENTE: Prof. VINCENZO LA CARRUBBA

PREREQUISITES	Fundamentals of chemistry and physics. Fundamentals of anatomy and physiology.
LEARNING OUTCOMES	Knowledge and understanding Introduction to the concept of biomedical device. Recall of the key concepts of cell biology, bioengineering, histology e anatomy and physiology useful for understanding the paradigm of biomedical device. Definition of the properties and characteristics of materials that can be used for biomedical devices to be used in clinical applications. Ability to apply knowledge and understanding Choice of the most appropriate processes and devices for a given biomedical device to be used in clinical applications Autonomy of judgment Identification of the most important characteristics and materials for biomedical devices, highlighting differences, similarities, advantages and disadvantages in a comparative way. Communication skills Students will be able to communicate with competence and scientific language the working principles of a biomedical devices, by using the appropriate engineering and medical lexicon. Learning skills Students will be able to address with a sufficient level of autonomy an anatomical/physiological issue that requires the use of a biomedical device, identifying the most suitable strategies for its choice and implementation in the clinical field
ASSESSMENT METHODS	The final examination consists of a written test followed by an oral examination. The written test, of the duration of about 3 hours, contains 3-5 open questions concerning all the subjects treated during the course. The oral examination will focus on aspects not sufficiently clarified by the student in the written test. The final assessment, properly graded, will be made on the basis of the following conditions: a) sufficient knowledge of subjects and theories addressed in the course; sufficient degree of awareness and autonomy in the application of theories to solve chemical problems (rating 18-21); b) Good knowledge of subjects and theories addressed in the course; fair degree of awareness and autonomy in the application of theories to solve chemical problems (rating 22-25); c) Good knowledge of subjects and theories addressed in the course; good degree of awareness and autonomy in the application of theories to solve chemical problems (rating 26-28); d) Excellent knowledge of subjects and theories addressed in the course; excellent level of awareness and autonomy in the application of theories to solve problems (rating 29-30L). The exam and the related evaluation will be the same for non-attending students.
TEACHING METHODS	Frontal teaching, practise

MODULE
BIOPHYSICS AND CELL PHYSIOLOGY

SUGGESTED BIBLIOGRAPHY

Fisiologia e Biofisica delle cellule di Taglietti e Casella - EdiSES
Fisiologia Medica di Guyton e Hall - Edra
Fisiologia Medica di Ganong - Piccin

AMBIT	50422-Funzioni biologiche integrate di organi, sistemi e apparati umani
INDIVIDUAL STUDY (Hrs)	45
COURSE ACTIVITY (Hrs)	30

EDUCATIONAL OBJECTIVES OF THE MODULE

To understand the physicochemical mechanisms and the molecular basis of the main cellular physiological processes.
The knowledge of the functioning of every organ and system.
The knowledge of the mechanisms of organ functional regulation.
Develop the ability to organize an integrated vision of the main functions of the body.

SYLLABUS

Hrs	Frontal teaching
1	The neuron: biophysics, excitability and conductivity
2	Synapses and chemical mediators
1	Receptors, physiological mechanisms of sensitivity and somatosensory cortex
1	Motor cortex.
1	The spinal cord. Reflex activity: mono and polysynaptic reflexes.
2	The skeletal muscle: structural and molecular basis of contraction. Cardiac muscle and smooth muscle.
1	Motor unit. Muscle tone and its regulation.
2	The morphological and functional characteristics of blood components: red blood cells, white blood cells, platelets, plasma proteins. Blood groups. Plasma and serum. Hemostasis.
3	Cardiac function: heart's electrical activity, cardiac cycle, cardiac output and its regulation.
1	Intrinsic and extrinsic innervation of the heart. Electrocardiogram.
1	Blood pressure and its regulation.
2	Respiratory mechanics. Lung volumes.
2	Alveolar and tissue respiratory gas exchanges. Transport of oxygen and carbon dioxide in the blood. Chemical and nervous control of breathing.
4	Motor, secretory, digestion and absorption functions of the digestive system. Regulatory mechanisms: the CNS, the enteric brain and gastrointestinal hormones. Liver and pancreas roles.
3	Functional bases of urine formation: glomerular filtration, tubular reabsorption and secretion, excretion.
3	Functions of the following endocrine glands: pituitary, thyroid, pancreas, adrenal cortex and medulla.

MODULE
BIOELECTRIC SIGNAL PROCESSING

Prof. RICCARDO PERNICE

SUGGESTED BIBLIOGRAPHY

- Luigi Landini: Fondamenti di analisi di segnali biomedici. Pisa University Press, 2013
- Suresh R. Devasahayam: Signals and systems in biomedical engineering - Signal processing and physiological systems modeling. Springer, 2nd edition, 2013
- Rangaraj M. Rangayyan: Biomedical signal analysis - a case-study approach. IEEE Press Series on Biomedical Engineering - John Wiley & Sons, 2002

AMBIT	50422-Funzioni biologiche integrate di organi, sistemi e apparati umani
INDIVIDUAL STUDY (Hrs)	90
COURSE ACTIVITY (Hrs)	60

EDUCATIONAL OBJECTIVES OF THE MODULE

The course aims to provide future doctors - techonological address with the knowledge and the key enabling technologies to enter the Biomedical Engineer profession, with regard to numerical processing of data acquired from biomedical equipment and
measurement systems. This course delivers knowledge with regard to: representation of time series obtained sampling continuous signals, and their spectral analysis, statistical description of signals using the concept of stochastic process and its corresponding frequency-domain description using spectral analysis based on classic techniques based on Fourier transform and novel methods based on parametric models; data representation through statistical estimators, and utilization of the most common approaches for statistical hypothesis testing.
The main objective of the course is to allow the student to exploit the acquired knowledge by developing and using algorithms within the MATLAB environment, analysing the most common bioelectrical signals (e.g. electrocardiographic, electroencephalographic). At the end of the course, the student will be able to describe a signal in the time and frequency domains employing both deterministic and statistical approaches, and to extract parameters of interest from the different signal representations. Thanks to the acquired software skills, the student will be able to deal with the most common biomedical signals and to extract physiological information of medical interest from such signals.

SYLLABUS

Hrs	Frontal teaching
3	Bioelectric signals: definition, examples.
3	Introduction to MATLAB for biomedical signal processing.
12	Numerical processing of biomedical signals: filtering and spectral analysis.
6	Electrocardiographic (ECG) signals: acquisition and processing. Heart rate variability analysis.
6	Photoplethysmographic (PPG) signals: acquisition and processing.
3	Electroencephalographic (EEG) signals: acquisition and processing.
7	Probability, performance metrics of diagnostic tests; statistical analysis of biomedical signals

Hrs	Practice
6	Exercises in classroom on course topics on numerical processing of biomedical signals.
14	Exercises in classes using MATLAB on course topics: writing of scripts and functions, FFT, filtering of biomedical signals. Signal processing in MATLAB: application to electrocardiographic, photoplethysmographic and electroencephalographic signals.

MODULE
BIOMEDICAL DEVICES

Prof. VINCENZO LA CARRUBBA

SUGGESTED BIBLIOGRAPHY

Medical Device Technologies A system based overview using engineering standards. Edited by: Baura G.D. Elsevier ISBN: 978-0-12-374976-5
Reviews, book chapters, scientifc articles and slides supplied in electronic format

AMBIT	50422-Funzioni biologiche integrate di organi, sistemi e apparati umani
INDIVIDUAL STUDY (Hrs)	75
COURSE ACTIVITY (Hrs)	50

EDUCATIONAL OBJECTIVES OF THE MODULE

1. Introduce the fundamentals of prosthetic systems
2. Define the main structural and functional properties of the materials used for biomedical devices
3. Review the main biomedical devices used in various zones of the human body
4. Choose the most appropriate device for the targeted anatomical district

SYLLABUS

Hrs	Frontal teaching
4	Introduction to biomedical devices, engineering in diagnosis and therapeutic treatments
4	Differences between intra-, extra-, para-corporeal devices
5	Overview of biomedical devices and artificial organs (cardiovascular, musculoskeletal, respiratory and other body areas)
5	Cardiac pacing systems, defibrillators (external and internal), pacemakers, stents, endoprostheses, catheters, mechanical and surgical valves, LVAD cardiovascular assist devices
4	Knee, hip and shoulder prosthetics
3	Mechanical ventilation, artificial lungs
4	Artificial kidney, Transjugular Intrahepatic Porto-systemic Shunt (TIPSs) of the liver
6	Orthodontic implants, breast implants, ocular implants and cochlear implants
3	Notes on the functioning of rehabilitation robotics, robotic surgery and minimally invasive surgery, computer- assisted surgery, wearable devices and ICT solutions

Hrs	Practice
12	Examination of case studies related to biomedical devices