Co-funded by the Erasmus+ Programme of the European Union

Розроблено в рамках проекту "Erasmus+ (CBHE) BioArt "Інноваційна мультидисциплінарна освітня програма зі штучних імплантів для біоінженерії для бакалаврів та магістрів"
Developed in the frame of project "Erasmus+ (CBHE) BioArt "Innovative Multidisciplinary Curriculum in Artificial Implants for Bio-Engineering BSc / MSc Degrees" (586114-EPP- 1-2017- 1-ES- EPPKA2-CBHE- JP).

DESCRIPTION/Syllabi of Curricula/Module

Short Name of the University/Country code **Date (Month / Year)**	**VNTU / UA** **Sep 2019**
TITLE OF THE MODULE	**Code**
Basics of biosign measurements Sensors and sensors for measuring biomedical signals and implant diagnostics (discipline - Measuring converters and sensors for medical and technical systems)	

Teacher(s)	**Department**
Coordinating: As. Prof. Leonid Koval, Ph.D. **Others:**	Dep. for Biomedical Engineering

Study cycle **(BA/MA)**	**Level of the module** **(Semester number)**	**Type of the module** **(compulsary/elective)**
Bachelor	5th (third year) for Bachelor	Compulsory

Form of delivery **(theory/lab/exercises)**	**Duration** **(weeks/months)**	**Language(s)**
Lectures, exercises, laboratory study	18 weeks / 4 months	Ukrainian, English

Prerequisites	
Prerequisites: Knowledge: basic knowledge of electronics, analog circuitry, biophysics, anatomy and physiology Skills: none Competences: none	**Co-requisites (if necessary):** none

ECTS (Credits of the module)	Total student workload hours	Contact hours	Individual work hours
5,5	165	81	84

Aim of the module (course unit): competences foreseen by the study programme

Students should be able to:

- to study and apply new methods and tools of analysis, modeling of designing and optimization of medical devices and systems;
- effectively use tools and methods for analysis, design, calculation and testing in the development of biomedical products and services;
- to apply physical, chemical, biological and mathematical methods in the analysis, modeling of functioning of medical digital devices and systems;
- to conduct research and observations on the interaction of biological, natural and artificial systems (prostheses, artificial organs, etc.).

Learning outcomes of module (course unit)	Teaching/learning methods (theory, lab, exercises)	Assessment methods (written exam, oral exam, reports)
Knowledge: Applicants gain extensive knowledge of the construction and use of electrodes, measuring transducers, sensors in biotechnical systems and devices.	Slides, lecture notes, suggested books and literature, personal reports, written papers	Written/oral exam, essays
Skills: Conduct analysis, design and use of electrodes, transducers, sensors in biotechnical systems and devices.	Lectures, working groups, individual work	Exercise and lab reports
Competences: Perform critical literature research on the subject, use the knowledge in practice, exchange notions, present the results	Working groups	Exercise reports and presentations

Themes	Contact work hours							Time and tasks for individual work	
	Lectures	Consultations	Seminars	Practical work	Laboratory work	Placements	**Total contact work**	**Individual work**	**Tasks**
Genesis of bio signals in the human body.	5						**3**	**10**	To study and understand the questions: Internal organs, tissues, skin as electrical generators. Electrical resistance of living tissues. A simplified model for the generation of EMF cells and organs. The concept of "average" common electrode and its meaning in the registration of bioelectric signals. Diagrams of leads with averaged electrode.
Types of electrodes and converters of biosignals.	5						**3**	**9**	To study and understand the questions: Electrodes, pastes, conductors, electrode switches. Electrodes. Purpose and main characteristics. Requirements for electrodes. Pastes and their requirements. Electrode conductors and electrode switches.
Sensors and physical phenomena of transformation of energies and physical quantities.	5						**3**	**9**	To study and understand the questions: Components of sensors. Sensor properties. Physical essence of transformation: change of physical properties, thermal energy, Seebeck effect and pyroelectric effect, Peltier effect, photovoltaic effect, photoconductivity effect, Zeeman effect, Faraday effect, Hall effect, magnetostriction, piezoelectric effect.
Features of measurements during skin-electrode contact.	5						**3**	**9**	To study and understand the questions: Classification of subcutaneous and subcutaneous electrodes. Artifacts of electrode systems. Typical electrode designs for electrophysiological studies.
Sensors for biochemical research.	5						**3**	**9**	To study and understand the questions: The concept of a biochemical sensor. Biochemical sensor. Clark's oxygen electrode and its electrochemical sensors. Properties of biosensors. Sensory organ biosensors. Sensor systems. Dynamic range. Sensory cell morphology. Mechanisms of sensory transduction.
Sensors of clinical trials.	5						**3**	**9**	To study and understand the questions: Basic indicators of blood gases. Spectrophotometric oximetry. Photoplethysmography. Capnometry. Anesthesia monitoring and multi-gas analyzer. Respiratory sensors. Contact,

									resistive, pneumatic and thermistor sensors. Spirometric sensor of turbine type. PNV sensor. Thermagnetic gas analyzer.
Sensors for diagnostic equipment.	5						**3**	**10**	To study and understand the questions: Methods and sensors of radiology. Computed tomography. Magnetic resonance imaging (MRI) methods and sensors. Conventional MRI. MR diffusion. MR perfusion. MR spectroscopy. MR angiography. Functional MRI. Temperature measurement using MRI. Methods and sensors of electroencephalography. Neural processes in the human brain. Electroencephalographic sensors. The concept of the channel. Types of leads. Electrode location indexing. Methods for the study of electroencephalograms.
Thermal biomedical sensors.	5						**3**	**9**	To study and understand the questions: Sensors and sensors of body temperature, internal organs and artificial implants. Contact thermal sensors. Mercury thermometers. Digital medical thermometers. Medical thermistors. Medical thermocouples. Contactless thermal sensors. Pyrometric sensors. Medical thermographs.
Intelligent sensors and nanosensory systems.	5						**3**	**10**	To study and understand the questions: General concepts about intelligent sensors. Integrated sensors. Sensor interfaces. Sensors based on optical waveguides with photonic-crystalline structure. Sensors based on carbon nanotubes. Nanobiosensors for Implant Diagnosis. Multisensor electronic odor and taste detectors. Trends in the development of sensors of physical quantities and methods of measurement in biometrics/
Practical work				2 2 2 2 2 2 2 2 2			**18**		Elements of electrical safety of medical equipment. Varieties and features of physical quantities. Electromagnetic sensors Touch sensor electronic control Sensory information in the system of coordination of living organisms One-dimensional multistage sensors Coordination of primary converters of physical quantities with computers. Measuring converters of electrical parameters Methods of processing information from nanosensors
Laboratory work					2 2		**18**		Research of electrical properties of biological tissues Investigation of sensors for

									electrocardiography
					2				Research of biochemical converters
					2				Investigation of sensors and sensors for temperature measurement
					2				Investigation of sensors for pressure measurement
					2				Investigation of strain gauges for mechanical diagnostics of implants
					2				Investigation of sensors of measurement of air composition
					2				Sensor research for non-destructive implant control
					2				Research of intellectual sensors
Final exam									
Total	**45**			**18**	**18**		**81**	**84**	

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Assessment strategy	Weight in %	Deadlines	Assessment criteria
Practical works attendance and exercise reports	20		Attendance and reports
Laboratory study and lab reporst	20		Attendance and reports
Colloquium (theory control)	25		Test
Individual tasks	10		Essays and presentations
Final exam	25		Written/oral exam

Author	Year of issue	Title	No of periodical or volume	Place of printing. Printing house or internet link
Compulsory literature				
Krzysztof Iniewski	2017	Biological and Medical Sensor Technologies	ISBN 978-1-138-07321-0	CRC Press
Ndjountche, Tertulien	2016	Chemical Sensors and Biosensors for Medical and Biological Applications	ISBN-10: 3527288554	Wiley-VCH
Ursula E. Spichiger-Keller	1998	Digital Electronics 2: Sequential and Arithmetic Logic Circuits	Vol. 2. ISBN: 978-1-848-21985-4	John Wiley & Sons
Kyung, C.-M., Yasuura, H., Liu, Y., Lin, Y.-L. (Eds.)	2017	Smart Sensors and Systems: Innovations for Medical, Environmental, and IoT Applications	ISBN 978-3-319-33201-7	Springer
Н.А. Кореневский, Е.П. Попечителев, С.А. Филист	1999	Проектирование электронной медицинской аппаратуры для диагностики и лечебных воздействий: монография		Курск: Курская городская типография
Additional literature				
Nordin, Margareta, and Victor Hirsch Frankel, eds	2001	Basic biomechanics of the musculoskeletal system		Lippincott Williams & Wilkins
Nilanjan Dey Jyotismita	2019	Sensors for Health	ISBN:	Academic Press

Chaki Rajesh Kumar		Monitoring 1st Edition	9780128193617	
George K. Knopf, Amarjeet S. Bassi	2018	Smart Biosensor Technology	ISBN 9781498774482	CRC Press Published

This project has been funded with support from the European Commission. This publication / communication reflects the views only of the author, and the Commission cannot be held responsibility for any use which may be made of the information contained therein.