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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**<br>**Date (Month / Year)** | **VNTU / UA**<br>**Sep 2019** |
|---|---|
| **TITLE OF THE MODULE** | **Code** |
| Firmware for implants and medical devices and implants<br><br>Medico-technical support for implants and medical devices and implants<br><br>(discipline - Hardware and software and medical engineering support of bioengineering and medical devices and systems) | |

| **Teacher(s)** | **Department** |
|---|---|
| **Coordinating: As. Prof. Serhii Tymchyk, Ph.D.**<br><br>**Others:** | Dep. for Biomedical Engineering |

| **Study cycle**<br>**(BA/MA)** | **Level of the module**<br>**(Semester number)** | **Type of the module**<br>**(compulsary/elective)** |
|---|---|---|
| MA | 1 semester | Variable |

| **Form of delivery**<br>**(theory/lab/exercises)** | **Duration**<br>**(weeks/months)** | **Language(s)** |
|---|---|---|
| Lectures, exercises,<br>Practical training | 18 weeks / 4 months | Ukrainian, English |

| Prerequisites | |
|---|---|
| **Prerequisites:**<br><br>Knowledge: basic knowledge of design, construction of biotechnical systems, construction of object models, processing of biomedical information<br><br>Skills: none<br><br>Competences: none | **Co-requisites (if necessary):**<br><br>none |

| ECTS (Credits of the module) | Total student workload hours | Contact hours | Individual work hours |
|---|---|---|---|
| 4 | 120 | 54 | 66 |

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

Students should be able to:

- to develop a working hypothesis, to plan and set up experiments to test the hypothesis and achieve an engineering goal with the help of appropriate technologies, technical tools and tools;
- to create and improve the means, methods and technologies of biomedical engineering for research and development of bioengineering objects and systems of medical and technical purpose;
- analyze complex medical engineering and bioengineering problems and formalize them to find quantitative solutions using modern mathematical methods and information technologies;
- solve complex problems of biomedical engineering with application of methods of mathematics, natural sciences and engineering sciences;
- to study biological and technical aspects of functioning and interaction of artificial biological and biotechnical systems.

| Learning outcomes of module (course unit) | Teaching/learning methods (theory, lab, exercises) | Assessment methods (written exam, oral exam, reports) |
|---|---|---|
| **Knowledge:** The students will obtain wide knowledge on the mechanisms of interaction of biomaterials with blood, technologies and equipment for blood purification. | Slides, lecture notes, suggested books and literature, personal reports, written papers | Written/oral exam, essays |
| **Skills:** Conduct analysis, development and application of biotechnical systems; determine the structure of relevant biotechnology systems; apply artificial objects in biomedical engineering. | Lectures, working groups, individual work | Exercise and practical 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** |
| Methods for analysis of biosignal parameters | 3 | | | | | | **3** | **6** | To study and understand questions: Classification of methods and their content. Histogram, skaterogram, fashion, variation span. Statistical indicators of biosignals for clinical analysis. Spectral Fourier transform: forward and reverse. Berg-Fourier conversion. Spectral characteristics of biosignals. |
| Hardware and Software for Biotechnical and Medical Devices and Systems (BTMDS) | 2 | | | | | | **2** | **6** | To study and understand questions: BTMDS Hardware and Software. General requirements. Hardware structure. Interface security. Software. Functional subsystems of hardware and software. |
| ethodologies for designing BTMDS hardware and software | 2 | | | | | | **2** | **5** | To study and understand questions: Methodologies for designing BTMDS hardware and software. Common approaches. Classification of principles of construction. Criteria for openness of the system. The only information space. External and internal design of BTMDS hardware and software. General approaches to information systems design |
| The life cycle of BTMDS hardware and software | 2 | | | | | | **2** | **5** | To study and understand the issues: BTMDS hardware and software design technologies. Design standards. Requirements for information systems design technology. The life cycle of BTMDS hardware and software. Life cycle models. Structure of project works. Classical and specialized methodologies for designing BTMDS hardware and software. |
| Standalone functional-complete module | 2 | | | | | | **2** | **6** | Explore and understand questions: The concept of a stand-alone functionally completed module. Patient electrical safety issues. Hardware protection of information. Functional-completed module structure. Functioning algorithm. |
| Universal measuring channel | 3 | | | | | | **3** | **6** | Explore and understand questions: Computer Measurement Channel (CMC). Structure and function. Modular construction principle. Requirements for CMC element base |

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| Structured organization of information support | 2 | | | | | | **2** | **5** | Explore and understand questions: Structured organization of information support. Principles and classes of evidence-based medicine. Generalized block diagram of adaptive information support. Software protection of information in the BTMDS hardware and software |
| Automated system of support and provision of doctor's decisions | 2 | | | | | | **2** | **5** | Explore and understand questions: Automated system of support and provision of doctor's decisions. Functional diagram of decision-making processes by a physician. General structure of the medical expert system. Information support infrastructure in medicine. Structure, organization and algorithms of functioning of automated workplaces. |
| Requirements for the structure and composition of the technical component of the biotechnical system | 3 | | | | | | **3** | **6** | Explore and understand questions: Generalized structure of BTS. Determination of technical component. The composition of the technical component. Requirements for the construction materials from which the sensors are made. The principle of multisystems in the construction of BTS. BTS hardware. Functions and structure of the technical component. Software component of BTS. Training device. Peripheral subsystem. Removal of artifacts and obstacles by methods of spectral filtration, stabilization of isolines, scheme by technical methods |
| Determination of biological component and its characteristics in terms of physical well-being of the individual | 2 | | | | | | **2** | **5** | Explore and understand questions: The concept of physical well-being of the individual. Information-structural model of personality of personnel. Determination of biological component. Criteria for emotional well-being. Requirements for the element base of biomedical equipment. |
| Methodology for designing medical expert systems | 2 | | | | | | **2** | **5** | Explore and understand questions: Method of systematic modeling analysis to describe the subject area of the expert system. Subject area analysis. Functional and information models of the subject area. The concept of competence of experts. Methods and criteria for determining the competence of experts. |
| Medical and technical support BTMDS for sports medicine | 2 | | | | | | **2** | **6** | Explore and understand questions: Requirements for medical equipment of BTMDS for sports medicine. Concept of creating computer software for medical equipment. Classification of computer programs. Sensor requirements. Features of constructive implementation of medical and technical support BTMDS for sports medicine. |

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| Practical training | | | | 2<br><br><br>2<br><br><br>2<br>2<br><br><br><br>2<br><br>2<br><br><br>2<br><br><br>3<br><br>2<br><br>3<br><br><br>3<br>2 | | | **27** | | 1. Study of technological possibilities of laser radiation for cutting of biocompatible materials.<br>2. Investigation of the technological process of debugging a CNC laser machine<br>3. Creating models for cutting<br>4. The process of manufacturing parts of artificial implants and prostheses on the example of different materials (artificial leather, plastics, metals)<br>5. Formation of blind holes in laser processing<br>6. Investigation of the accuracy of forming holes and contours in laser processing of biocompatible materials<br>7. Investigation of the influence of laser cutting modes of biocompatible materials on the quality indicators of the process.<br>8. Development of measuring channel for biotechnical system.<br>9. Development of user interface for biotechnical system.<br>10. Development of a system for measuring and transmitting bio-object indicators.<br>11. Development of database structure<br>12. Analysis of means for photoplethysmography and pulse oximetry. |
| Final exam | | | | | | | | | |
| **Total** | **27** | | | **27** | | | **54** | **66** | |

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| Assessment strategy | Weight in % | Deadlines | Assessment criteria |
|---|---|---|---|
| Practical works attendance and exercise reports | 25 | | Attendance and reports |
| Colloquium (theory control) | 40 | | 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 |
| Andreas Inmann, Diana Hotgins | 2013 | Implantable sensor systems for medical applications | ISBN 9781845699871 | Woodhead Publishing |
| Yang, Guang-Zhong (Ed.) | 2018 | Implantable Sensors and Systems: From Theory to Practice | ISBN 978-3-319-69748-2 | Springer |
| 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 |

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|---|---|---|---|---|
| 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 Chaki Rajesh Kumar | 2019 | Sensors for Health Monitoring 1st Edition | ISBN: 9780128193617 | Academic Press |
| George K. Knopf, Amarjeet S. Bassi | 2018 | Smart Biosensor Technology | ISBN 9781498774482 | CRC Press Published |

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