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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
TITLE OF THE MODULE	**Code**
New materials and composites	

Teacher(s)	**Department**
Coordinating: Sergey Sukhorukov, PhD **Others:**	Machine building technology and automation

Study cycle **(BA/MA)**	**Level of the module** **(Semester number)**	**Type of the module** **(compulsary/elective)**
BA	6th semestr (3 year) for Bachelor	Compulsary

Form of delivery **(theory/lab/exercises)**	**Duration** **(weeks/months)**	**Language(s)**
Lectures/lab/exercises	12 weeks	Ukr / English

Prerequisites	
Prerequisites: Knowledge: materials engineering, physics, chemistry Skills: ability to search information Competencies: None	**Related disciplines (if required):** no

ECTS (Credits of the module)	Total student workload hours	Contact hours	Individual work hours
3	90	48	42

Aim of the module (course unit): competences foreseen by the study programme		
Students should be able to: - to effectively use tools and methods for analysis, design, calculation of tests in the development of products from composite materials. - to identify, formulate and solve engineering problems for the effective use of the mechanical characteristics of composites to improve existing structures for various purposes, and to develop fundamentally new structures and their assemblies. Find, analyze and compare information of new materials and nanostructures. Understand the requirements for biomedical composite materials and products made of them, the physical and mechanical properties of biomedical composite materials and master the methods of designing products made of them.		
Learning outcomes of module (course unit)	**Teaching/learning methods (theory, lab, exercises)**	**Assessment methods** **(written exam, oral exam, reports)**
Knowledge: Producers gain extensive knowledge of the basic manufacturing processes of composite and nanomaterials; modern advances in the methods of calculation, manufacture and testing of composites and nanomaterials; types, properties, characteristics and principles of using complex biomaterials; types of quality control and conditions of use of composite medical materials, artificial organs and dentures.	Slides, lecture notes, suggested books and literature, personal reports, written papers	Written/oral exam, essays
Skills: Conduct research into the mechanical properties of composite materials, analyze and predict their applicability in the human body, calculate the physical and mechanical characteristics of the	Lectures, working groups, individual work	Exercise and laboratory reports

composite material and the feasibility study of its use.		
Competences: Conduct critical analysis of literature, results of research of new materials and nanostructures, apply knowledge in practice, exchange opinions and substantiate conclusions, present results	Working groups	Exercise reports and presentations

Themes	Contact work hours							Time and tasks for individual work	
	Lectures	Consultations	Seminars	Practiacl work	Laboratory work	Placements	**Total contact work**	**Individual work**	**Tasks**
1. Composite materials	3						**3**	**3**	To study and understand questions: General idea about composites. Fibrous and layered composites. Classification of composite materials. Operational and technological requirements for composite materials. The concept of chemical and physical compatibility of the components of the composition.
2. Composite production technologies and their structural mechanics	3						**3**	**3**	To study and understand questions: Basic industrial methods of manufacturing composite materials. Methods of impregnation of fibers by melt matrix. Impregnation in an inert atmosphere. Combined methods of impregnation. Estimated methods of determining the leakage pressure. Basic concepts of structural mechanics of composites. Approximate methods for determining stresses in components of compositions. Strength criteria of structural elements of composites.
3. Powder materials	3						**3**	**2**	To study and understand questions: Raw materials of powder metallurgy. Methods of producing powders. Basic laws of the process of pressing metal powders. The regularities of the sintering process of powder materials.
4. Nanostructures and nanomaterials	3						**3**	**3**	To study and understand questions: Introduction, basic information on nanotechnology, nanostructures and nanocapsules, nanomaterials.
5. New carbon based materials	3						**3**	**3**	To study and understand questions: Graphene. Properties of graphene and its scope. Carbon nanotubes. Nanohorns, nanocones and nanocoils.
6. New materials based on metals and polymers	3						**3**	**2**	To study and understand questions: Metallic nanostructures, metallic nano-oxides. polymeric nanostructures and nanocapsules, micelles and liposomes.
7. Bioceramics	3						**3**	**3**	To study and understand questions: Application of ceramic materials in medicine. Ceramet. Corundum bioceramics. Bioglass. Materials on the basis of hydroxyapatite.

									Transformational strengthening of biomaterials. Advantages and disadvantages of bioceramic materials. Technology of obtaining bioceramics.
8. Polymeric biomaterials	3						**3**	**3**	To study and understand questions: Natural polymers as biomaterials. Application of synthetic polymers in medicine. Biocomposites. Carbon-carbon composites based on carbon fibers. Composites based on polymer matrix. Properties of biodegradation of polymers. Structural materials. Stitch materials. Insulating materials. Polymeric prostheses and artificial fabrics. Waste processing and utilization in the production and application of biomaterials
9. 3D printing	3						**3**	**2**	To study and understand questions: Additive manufacturing. Rapid modeling, manufacturing, tooling. Types of 3D printing: SLA, LOM, FDM, JM, BJ, SLS, SLM, LENS. Materials for 3D printing.
10. Fundamentals of tissue engineering	3						**3**	**2**	To study and understand questions: Principles and scientific basis of tissue engineering. Materials and technology of fabrication. Methods of fabric assembly. Biological 3D printing. Intelligent (intellectual) materials. Intelligent technologies in prosthetics. Biosensors
Practical study				2 2 2 2			**12**	**6**	Determination of the average strength of the composites and their dispersion (equipment: universal bench testing machine UIT STM). Determination of the strength of bundles of continuous reinforcing fibers and their design schemes. Methods of compaction of porous materials (equipment: desktop pres machine) The main laws of the process of presowing powders. Analysis of presumption processes. Development of a composite material based on silicon fibers (equipment: laptop, Autodesk Inventor software). Calculation of a composite material reinforced with silicon fibers and determination of its physical and mechanical properties. Design 3D model and manufacturing of artificial implant (equipment: laptop, Autodesk Inventor software,

				2 2					desktop 3D printer). Development of 3D model of the artificial implant and its manufacture using 3D printing. Numerical FEM simulation of deformations of the artificial implant (equipment: laptop, Autodesk Inventor software). Development of 3D model of artificial implant. Numerical modeling and analysis of the strength of artificial implant. The study of shape memory in structural biomaterials (equipment: digital Trinocular Levenhuk microscope). Observation of a change in shape in microsamples of biomaterial. Determination of martensitic deformation conditions.
Laboratory study					2 2 1 1		**6**	**10**	Determination of the mechanical characteristics of composites under tension. (equipment: universal desktop testing machine UIT STM). Algorithm and methodology of experimental research. Methodology for processing experimental results. The study of structural and surface changes. Determination of the mechanical characteristics of porous sintered materials under tension. (equipment: universal desktop testing machine UIT STM) The development of methods for calculating the strength and ductility of porous sintered materials from the tensile diagram and the measurement results. Determination of the mechanical characteristics of artificial implants made using 3D printing (equipment: desktop 3D printer, universal desktop testing machine UIT STM). The basic relationships for calculating the mechanical characteristics of materials for 3D printing. Features of experimental studies of the strength of artificial implants and methods for processing experimental results. Testing of polymer biomaterials (equipment: universal desktop testing machine UIT STM). The study of the physical properties of biomaterials, the determination of

									the state of the material in different periods of operation.
Total	30			12	6		48	42	

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

Author	Year of issue	Title	No of periodical or volume	Place of printing. Printing house or internet link
Compulsory literature				
K. Kumar and J. Paulo Davim	2018	Composites and Advanced Materials for Industrial Applications		IGI Global
V Rajendran	2015	Advanced Nanomaterials		Bloomsbury India
I.M. Low	2014	Advances in Ceramic Matrix Composites		Woodhead Publishing Limited
Mohammad Jawaid, Mohamed Thariq and Naheed Saba	2019	Durability and Life Prediction in Biocomposites, Fibre-Reinforced Composites and Hybrid Composites		Woodhead Publishing
John P. Paul	2016	Biomaterials in artificial organs		Springer
Бурєнніков Ю. А., Сивак І. О., Сухоруков С. І.	2012	Нові матеріали та композити: навчальний посібник		ВНТУ
Additional literature				
Nongyue He and Zhiyang Li	2016	Biomaterials Science	No 7.1. – P. 1-812	Science
Sarabjeet Singh Sidhu, Preetkanwal Singh Bains, Redouane Zitoune and Morteza Yazdani	2018	Futuristic Composites		Springer

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