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

DESCRIPTION/Syllabi of Curricula/Module

Short Name of the University/Country code Date (Month / Year)	DSEA Jan 2019
TITLE OF THE MODULE	**Code**
Regenerative engineering and design of optimal structures	

Teacher(s)	Department
Coordinating: Olexander Altukhov, PhD **Others:**	Department of Computer and Information Technology (CIT)

Study cycle (BA/MA)	Level of the module (Semester number)	Type of the module (compulsary/elective)
Master	2^{th} semester (first year) for Master	elective

Form of delivery (theory/lab/exercises)	Duration (weeks/months)	Language(s)
Lectures, lab	8 weeks	Ukrainian / English

Prerequisites	
Prerequisites: Human anatomy and physiology, mechanics of solids, structure of polymers, protein, polysaccharides, metals and non metal elements, atomic bonding.	**Co-requisites (if necessary):**

ECTS (Credits of the module)	Total student workload hours	Contact hours	Individual work hours
5,5	165	72	93

Aim of the module (course unit): competences foreseen by the study programme		
Students should be able to: formation of cognitive, affective and motor competencies in the study and explanation of a set of basic concepts and knowledge of regenerative engineering and design of optimal structures, implant design using computer-aided design systems, computer skills in biomedical equipment and implants, according to individual anatomical features.		
Learning outcomes of module (course unit)	**Teaching/learning methods (theory, lab, exercises)**	**Assessment methods (written exam, oral exam, reports)**
Knowledge: • to teach the future specialist in computer science knowledge and use of fundamental concepts and practical solutions that underlie modern technologies of regenerative medicine; • acquaintance with the basic principles of restoration of the lost human functions; • consideration of areas of regenerative medicine; • gaining skills in choosing technologies to restore the lost capabilities of the human body; • formation of skills and abilities to use the tools of design and modeling of biomedical equipment and implants.	Work with the lecture notes as well as on the available fundamental subject literature	Knowledge test
Skills: - perform modeling and research of technical, organizational and technical systems, products and medical systems; use methods of research of operations, solution of one- and multi-criteria optimization problems of nonlinear programming; - apply design information technologies to develop optimal structures and model the behavior of mechanical and biomechanical objects, automated design of products for various purposes, as well as the use of virtual reality technologies for modeling and learning tasks.	Lectures, lab, consultation	Active attendance on lectures, individual project and presentation

Competences: - ability to independently identify, set and solve problems, develop and implement projects, including their own research; - ability to apply methods of operations research and mathematical programming in modeling and design of complex computerized technical systems; - ability to model mechanical objects and provide support for the design of products for various purposes using modern information technology for the design of optimal structures and modeling.	Lectures, practiacl work, consultation	Individual project and presentation

Themes	**Contact work hours**							**Time and tasks for individual work**	
	Lectures	Consultations	Seminars	Practiacl work	Laboratory work	Placements	**Total contact work**	**Individual work**	**Tasks**
Regenerative medicine and biotechnology in orthopaedics									
1. An overview of regenerative medicine. Scope of anatomy, physiology and basic terminology. Functional biomaterials for regenerative medicine. Introduces the recent trends of smart natural biomaterials for regenerative medicine. Biocompatibility: Methods for testing and evaluating biocompatibility: In Vitro Testing, In Vivo Testing.	4				2		**6**	**10**	Study exam/ complete exercise
2. Dental implant modalities: Dentures, Subperiosteal, Endosteal; Blade type, Root form, Packaging and preparation of dental implants. Cardiac implants, Opthalmic implants, Vitreous Implants.	2				2		**4**	**10**	Study exam/ complete exercise
3. Bones and Joints: Structure and function of skeleton, types of joints and their disorders. Orthopedic implants:	4				4		**8**	**10**	Study exam/ complete exercise

Temporary fixation devices, Fracture healing, Repair of the ligaments, ACL reconstruction using biological and synthetic materials, Joint replacements: Total Hip replacement, Total knee replacement, Bone regeneration with re-sorbable material.									
Mechanical design methods for bio-mechanical engineering									
4. Virtual Prototyping. Virtual prototyping is the backbone of the e-Design paradigm. Product modeling and simulations using integrated CAD/CAE/CAM software.	4				4		**8**	**10**	Study exam/ complete exercise
5. Finite element modeling. Topology Decomposition Approach. Geometry Decomposition Approaches. Grid-Based Approach. Improvement of Mesh Quality. Fundamentals of Dental Implant Biomechanics. Interface between Bone and Implant. Assumptions of Detailed Geometry of Bone and Implant. Material Properties. Boundary Conditions.	6				4		**10**	**13**	Study exam/ complete exercise
6. Physical Prototyping. Rapid prototyping (RP) systems, based on solid freeform fabrication (SFF) technology (Jacobs 1994), fabricate physical prototypes of the structure for design verification. Computer numerical control (CNC) machining fabricates functional parts as well as the mold or die for mass production of the product.	3				4		**7**	**13**	Study exam/ complete exercise
7. CNC Machining. The machining operations of virtual manufacturing: milling, turning, and drilling, planing the machining process.	3				6		**9**	**13**	Study exam/ complete exercise

Generating the machining tool path, visualize and simulate machining operations, and estimate machining time. Converting into CNC codes (M-codes and G-codes) to fabricate functional parts as well as a die or mold for production.									
8. 3D bioprinting techniques in regenerative medicine. Definition and principles of 3D printing. 3D bioprinting technologies: Ink-Jet-based bioprinting, Pressure-assisted bioprinting, Laser-assisted bioprinting, Solenoid valve-based printing, Acoustic-jet printing. Biopriting for skin. Organ printing. Cell, stem cell printing. 3D printing for orthopedic implants.	4				4		**8**	**14**	
Total of basic part	**30**				**30**		**72**	**93**	

Assessment strategy	**Weight in %**	**Deadlines**	**Assessment criteria**
written exam theory	40%	during the semester / exam	Good response to the questions
Practical exam on a computer	60%	during the semester / exam	the work is done completely without mistakes or minor errors

Author	**Year of issue**	**Title**	**No of periodical or volume**	**Place of printing. Printing house or internet link**
Compulsory literature				
Atala, Anthony; Murphy, Sean V	2017	Regenerative medicine technology: on-a-chip applications for disease modeling, drug discovery and personalized medicine		CRC Press ISBN: 978-1-4987-1191-3
Srinivas D. Narasipura, Michael R. King	2012	Engineering Biomaterials for		Springer-Verlag New York

		Regenerative Medicine: Novel Technologies for Clinical Applications		ISBN: 978-1-4614-1079-9
Kursad Turksen	2015	Bioprinting in Regenerative Medicine		Springer International Publishing ISBN: 978-3-319-21385-9
Lijie Grace Zhang,John P Fisher,Kam Leong	2015	3D Bioprinting and Nanotechnology in Tissue Engineering and Regenerative Medicine		Academic Press ISBN: 9780128006641
Kuang-Hua Chang	2015	e-Design. Computer-Aided Engineering Design		Elsevier ISBN: 978-0-12-382038-9
Jianping Geng, Weiqi Yan, Wei Xu	2008	Application of the Finite Element Method in Implant Dentistry		Springer ISBN 978-3-540-73763-6
Additional literature				
Gerald Brandacher	2015	The Science of Reconstructive Transplantation		Humana Press ISBN: 978-1-4939-2070-9
Melba Navarro, Josep A. Planell	*2011*	Nanotechnology in Regenerative Medicine: Methods and Protocols		Humana Press ISBN: 978-1-61779-387-5