Bionic Design and Technologies

Classification	Module ID	Kind of Module	Number of Credits (ECTS)
		Elective	5

Location	Language	Duration of Module	Frequency of Module	Max. Number of Participants
Online	English	One Semester	Winter Semester	60

Module Convenor	Professor / Lecturer
Assoc. Prof. Dr. Tetiana Klochko	Assoc. Prof. Dr. Tetiana Klochko

Prerequisites*

Knowledge of materials science, higher mathematics and mathematical analysis, physics, industrial ecology and the fundamentals of the anatomy of living organisms.

*** Note: Please also note the prerequisites according to the examination regulations in the respective valid SPO version.**

Usability	Teaching Methods	Workload
The module is offered by the Department of Computer-Integrated Technologies of Device Production, Igor Sikorsky Kyiv Polytechnic Institute, as an elective module for the Digital Technology and Management Bachelor's degree programme. The usability in other courses of study must be checked in each individual case.	Lecture; practical exercises; problem-oriented collaborative learning; independent study	Contact time: 60 h Self-study: 60 h Exam preparation: 30 h Total effort: 150 h

Learning Outcomes
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After successful completion of the module, students will have acquired the following professional, methodological and personal skills and competencies:

Professional Skills:

- Students can explain the concepts, history, research directions and tasks of bionics and the principles of biodesign and tectonics of technical objects.
- Students are able to design artificial forms of technical objects using biological analogues and apply bionic methods in the design and control of complex automated systems.
- Students can describe biological and artificial neurons and neural networks, biosignals and bionic analogues of receptors and sense organs.
- Students can analyse and select structural biomaterials and additive technologies for bionic modules, prostheses and exoskeletons.

Methodological Skills:

- Students are able to build bionic models, identify the parameters of a mathematical model and assess its adequacy and sensitivity.
- Students can evaluate competing alternatives when making decisions on the control of technical objects based on the functioning mechanisms of living objects.

Personal Skills (Social Competence and Self-competence):

- Students are able to work actively and collaboratively in practical classes and defend their solutions orally.

Course Content

Concept, history and research directions of bionics; tectonics and composition in biodesign; reproducing prototypes from living nature and methods of bionic cognition; principles of bionic modelling and experimental investigation of material properties; the role of colour and light in the design of technical objects and ergonomics; neurobionics, nerve impulses and feedback in bionic prostheses and exoskeletons; biological and artificial neurons, synapses, structure, classification and training of neural networks; classification and genesis of biosignals, deterministic and stochastic signal models, information and diagnostic bionic systems; biological receptors and their bionic analogues: bionic eye, electronic nose, taste and hearing sensors; myology, musculoskeletal biomechanics and electromechanical modules of bionic complexes; additive technologies in bionic design; multi-criteria bionic complexes for industrial and medical applications.

Literature

1. Klochko T. R. (comp.) Fundamentals of Bionics: Lecture Notes: textbook. Kyiv: Igor Sikorsky KPI, 2024. 155 p. (in Ukrainian)
2. Tymchyk H. S., Skytsiuk V. I., Klochko T. R. Theory of Biotechnical Objects: monograph, in 3 volumes. Kyiv: NTUU KPI, 2019. (in Ukrainian)
3. Tymchyk H. S., Skytsiuk V. I., Klochko T. R. Information Technologies for Diagnosing the State of Biotechnical Objects: monograph. Kyiv: NTUU KPI, 2017. 344 p. (in Ukrainian)
4. Rudenko O. H., Bodianskyi Ye. V. Artificial Neural Networks: textbook. Kharkiv: SMIT, 2006. 404 p. (in Ukrainian)
5. Lepora N. F., Verschure P., Prescott T. J. The state of the art in biomimetics. Bioinspiration and Biomimetics 8.1 (2013): 013001.
6. George J. A. et al. Biomimetic sensory feedback through peripheral nerve stimulation improves dexterous use of a bionic hand. Science Robotics 4.32 (2019): eaax2352.

Internationality (content-related)

Bionics and biomimetics are international research fields; the module draws on international journal literature and on industrial and medical robotics examples from global practice.

Method of Assessment (if applicable, notes on multiple choice as form of examination - APO §9a)

Form of Examination*1)	Type/Scope incl. Weighting*2)	Learning Objectives/Competencies to be Assessed
Portfolio examination	Practical classes (16): 80 % Module test: 20 % Optional written credit test or interview for students below the pass mark or wishing to improve their grade	All of the above-mentioned competencies are assessed by way of the aforementioned examination forms.

*1) Please refer to the applicable overview of the forms of examination at the OTH Amberg-Weiden

*2) Please provide additional information on the weighting (in % share) and, if applicable, explain the bonus system.