National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Department of
biomedical engineering

Development and operation of physiotherapeutic medical devices

Working program of basic discipline (Syllabus)

Requisites for basic discipline	
Level of higher education	***First (bachelor's)***
Branch of knowledge	***16 Chemical and Bioengineering***
Specialty	***163 Biomedical Engineering***
Educational program	***Medical engineering***
Discipline status	***Selective discipline***
Form of study	***full-time / day / mixed / remote***
Year of preparation, semester	***4th course, Spring semester***
The scope of discipline	***4 ECTS credits / 120 hours***
Semester control / Control measures	***Test Work, Modular Test Work (MTW), Abstract***
Lessons schedule	***According to the schedule on the site https://schedule.kpi.ua/***
Language of instruction	***English***
Information about course leader / teachers	***Lecturer: Associate Professor,Bogomolov Mykola,*** nbogom@yahoo.com; mfbogomolov@gmail.com; m.bogomolov@kpi.ua ***Practical: Associate Professor,Bogomolov Mykola,*** nbogom@yahoo.com; mfbogomolov@gmail.com; m.bogomolov@kpi.ua ***Zoom: 779 2233 9663, code 7Pzg7d***
Teacher's profile	***Lecturer:*** **http://intellect.bmi.fbmi.kpi.ua/profile/bmf**
Course placement	***Platform «Sikorsky»*** https://do.ipo.kpi.ua/ course/view.php?id=2606

Distribution of hours				
Semester	**Lectures**	**Practical**	**Laboratory**	**Independent Student Work (ISW)**
Spring semester	***26***	***28***	***--***	***66***

Curriculum of the discipline

1. Description of the discipline, its purpose, subject of study and learning outcomes

The purpose of the discipline. *The main purpose of the discipline* ***" Development and operation of physiotherapeutic medical devices "*** *is to form students' ability to choose basic and auxiliary materials, methods and tools for the implementation of technical projects, to apply modern methods and methods of modeling in the design of medical equipment and medical devices; to carry out experiments according to the set technical and medical methods, to carry out computer processing, the analysis and synthesis of the received results.*

Skills required to study the discipline:

1. Knowledge and ability to use ***Microsoft Word, Microsoft PowerPoint****.*

2. Ability to abstract thinking, analysis and synthesis of new technologies using modern physiotherapy techniques, medical protocols and medical devices.

3. Ability to search, process, analyse scientific and technical information from various sources for optimal use and implementation of medical and technical requirements for the use of modern medical treatment technologies.

4. Knowledge of a foreign language.

5. Ability to work in a team of like-minded people and specialists in various fields of knowledge.

6. Ability to work in an international context to participate in comprehensive testing and advertising of research achievements in the implementation of modern physiotherapeutic treatment technologies.

7. Ability to analyse complex medical engineering and bioengineering problems and tasks, to formalize them to find quantitative solutions using modern statistical mathematical methods and microcomputer information technologies.

8. Ability to study biological and technical aspects of functioning and interaction of artificial biological neural networks and biotechnical systems.

9. Technical means of automated design medical equipment and systems.

10. Software tools for creating biomedical laser systems and optoelectronic elements.

11. Analysis of optical and mechanical components of therapeutic medical devices by finite element method (FEM).

Software competencies

Integral competence

IK	**The ability to solve complex tasks and problems in biomedical engineering or in the process of learning, which involves conducting research and/or implementing innovations and is characterized by uncertainty of conditions and requirements**

Studying the educational component strengthens the following general competencies:

ZK 1	**Ability for abstract thinking, analysis and synthesis (Reinforcement).**
ZK 2	**Knowledge and understanding of the subject area and understanding of professional activity (Reinforcement).**
ZK 4	**Skills in using information and communication technologies (Reinforcement).**
ZK 13	**The ability to preserve and multiply the moral, cultural, scientific values and achievements of society based on understanding the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society and in the development of society, technology and engineering, to use various types of physical activity for active recreation and leading a healthy lifestyle (Reinforcement).**
	Skills in using information and communication technologies in the design and operation of physiotherapeutic medical devices.
	Ability to evaluate and ensure the quality of work performed in the design and operation of physiotherapeutic medical devices.

Studying the educational component strengthens the following special (professional) competencies:

FK 2	**Ability to provide engineering expertise in the planning, development, evaluation, and specification of medical devices (Reinforcement).**
FK 7	**Ability to plan, design, develop, install, operate, maintain, service, control and coordinate the repair of devices, equipment and systems for prevention, diagnosis, treatment and rehabilitation used in hospitals and research institutes (Reinforcement).**
FK 12	**Ability to ensure and monitor compliance with safety and biomedical ethics when working with medical equipment (Reinforcement).**

	Ability to provide engineering expertise in the planning, development, evaluation, and specification of modern physiotherapy medical devices.
	The ability to apply physical, chemical, biological and mathematical methods in the analysis and modeling of the functioning of modern physiotherapeutic medical devices.
	The ability to identify, formulate, and solve engineering problems related to the interaction between living and non-living systems in the design and operation of modern physiotherapy medical devices.
	Здатність проводити експерименти за заданими технічними та медичними методиками, виконувати комп'ютерну обробку, аналіз і синтез отриманих результатів при розробці та експлуатації сучасних фізіотерапевтичних медичних приладів.

Studying the educational component reinforces the following program learning outcomes:

PRN 3	***Manage complex activities or projects, be responsible for making engineering decisions in unpredictable conditions, conduct feasibility and safety assessments of projects (Reinforcement).***
PRN7	***Provide engineering support, service, and technical maintenance during the operation of laboratory analytical equipment, medical diagnostic and therapeutic complexes and systems in accordance with the rules established by technical documentation and regulatory documents governing the procedures for commissioning, application, and repair of medical equipment, as well as to form the standard documentation by types of work according to the technical regulation on medical devices (Reinforcement).***
PRN10	***Be able to plan, organize, direct and control medical and bioengineering systems and processes (Reinforcement).***
PRN13	***Be able to analyze signals transmitted from organs to devices and process diagnostic information (signals and images) (Reinforcement).***
PRN22	***Knowledge of general principles and structure of complex biological systems, including the human body and its functions from the perspective of a systemic approach and their utilization in biomedical engineering, as well as basic methods and tools used for quantitative assessment of physiological system functioning (Reinforcement).***
PRN 23	***Development and implementation of modern diagnostic and therapeutic methods associated with the use of biotechnology, computer, and nanotechnology through the improvement of technical elements of medical devices and systems, as well as medical products, in the process of professional activity (Reinforcement).***
PRN24	***Being able to consider historical, social, environmental, ethical, legal, economic aspects, requirements of labor protection, industrial hygiene, and fire safety when forming technical solutions, taking into account the strengthening and preservation of personal and public health (Reinforcement).***
	Formulate logical conclusions and substantiated recommendations regarding the evaluation, operation and implementation of modern physiotherapeutic medical devices, medical and bioengineering tools and methods.
	Apply the provisions of regulatory and technical documents that regulate the procedure for product certification, certification of production and operation of modern physiotherapeutic medical devices.
	Be able to use databases, mathematical and software for data processing and computer modeling of modern physiotherapy medical devices.

	Knowledge of methods for studying objects, analyzing and processing experimental data in laboratory research and operating modern physiotherapeutic medical devices.
	Be able to analyze signals transmitted from organs to devices and process diagnostic information (signals and images) for the successful and effective use of modern physiotherapeutic medical devices.
	Possession of modern methods for testing the experimental integrity and performance of modern physiotherapeutic medical devices and determining their optimal characteristics.

Program learning outcomes, assessment measures, and deadlines are announced to students at the first lesson.

The subject of the discipline. The discipline ***"Development and operation of physiotherapeutic medical devices"***belongs to the cycle of elective disciplines of professional training of a specialist in the specialty ***163 "Biomedical Engineering"*** in the specialization **"Medical Engineering"** of the first (bachelor's) level of higher education for bachelor's degree, which provides training of specialists with higher education. Research of human diseases used in laboratory analytical equipment, which will allow to design and operate highly efficient diagnostic optoelectronic devices, perform their repair and maintenance, conduct research on the effects of various harmful external factors on the human body. The practical part is aimed at direct acquaintance with medical diagnostic technologies and relevant modern medical equipment directly in medical institutions: scientific and analytical review, design, construction, research, testing, operation and technical expertise, engineering and information support of laboratory analytical equipment and technologies, computer based processing of experimental medical information and signals to identify the presence of pathological areas, organs and tissues.

During training the following are applied: - strategies of active and collective learning; - personality-oriented development technologies based on active forms and teaching methods (team-based learning), pair work (think-pair-share), brainstorming method, case study method, business games, discussion etc.); - heuristic methods (methods of creating ideas, methods of solving creative problems, methods of creative thinking activation); - method of problem-oriented learning.

For more effective communication in order to understand the structure of the discipline and master the material using e-mail and ***WhatsApp messenger***, ***Skype***, platform ***https://do.ipo.kpi.ua*** through which: - simplifies the placement and exchange of educational material; - provides feedback to students regarding learning tasks and the content of the discipline; - students' learning tasks are evaluated; - the account of performance by students of the plan of educational discipline, the schedule of performance is conducted learning tasks and student assessment. During the training and for interaction with students, modern information and communication and network technologies are used to solve educational tasks such as **ZOOM** and **Cisco Webex Meetings**, as well as equipment (projector and electronic presentations for lectures and practical classes).

Program learning outcomes: As a result of studying the discipline " ***Development and operation of physiotherapeutic medical devices*** " students will be able to:

1. Choose the basic and auxiliary materials, methods and tools for the implementation of technical projects, to apply modern methods and methods of modeling in the design of medical equipment and medical devices.
2. Use methods and means of quantitative assessment of the functioning of physiological systems in practical engineering activities.
3. Implement modern diagnostic and treatment methods related to the use of biotechnology, computer and nanotechnology.
4. Conduct experiments according to specified technical and medical methods, perform computer

processing, analysis and synthesis of the results

5. Implement modern diagnostic and therapeutic methods related to the use of biotechnology, computer and nanotechnology.

6. Improve the technical elements of medical devices and systems in the process of professional activity.

7. Apply methods and tools for forecasting and modeling to study the behavior and properties of biological systems.

8. Work with information: find, evaluate and use information from various sources needed to solve scientific and professional problems.

The compliance of learning outcomes with the competencies according to the standard of higher education can be viewed in ***Appendix 1"Program learning outcomes (extended form)".***

2. Prerequisites and postrequisites of the discipline (place in the structural and logical scheme of education according to the relevant educational program)

The discipline " ***Development and operation of physiotherapeutic medical devices*** " is interdisciplinary. It integrates with its subject knowledge from other educational and scientific fields, in the structural and logical scheme of the training program that provides the following disciplines and credit modules:

1) Mathematical modelling and simulation of biomedical systems; 2) Modelling of biophysical systems and processes in medicine; 3) Mathematical methods of optimizing of biomedical signals and images; 4) Methods of identification, processing and optimization of medical information; 5) Quantitative physiology; 6) Instrumental methods of diagnosing human health, as well as disciplines of the unit of language and practical training.

The discipline " ***Development and operation of physiotherapeutic medical devices*** " is the basis for the preparation of bachelor's theses (projects, master's theses) in the specialty and in further practical work in the specialty.

- from selective disciplines (educational-professional program **"Biomedical Engineering"**): **"Medical Equipment", "Prosthetics and artificial organs", "Biomedical devices and systems".**

3. The content of the discipline

Program learning outcomes, control measures and deadlines are announced to students in the first lesson.

№ s/n	***Subject***	***Program learning outcomes***	***The main tasks***	
			Control measure	***Deadline***
1.	**General concepts about the development of medical devices. Commissioning procedure**	PRN3, PRN7, PRN 10, PRN13, PRN22, PRN23, PRN 24	***Practical work 1, 2***	***3rd week***
2.	**Basic medical and technical requirements for the development of medical devices.**	PRN3, PRN7, PRN 10, PRN13, PRN22, PRN23, PRN 24	***Practical work 3,4***	***4th week***

	Preparation of standard documentation.			
3.	**System analysis of biomedical equipment design. Engineering support during operation.**	PRN3, PRN7, PRN 10, PRN13, PRN22, PRN23, PRN 24	***Practical work* 5-8**	**5-6*th weeks***
4.	**Technical support for the development of medical devices. Technical regulations for medical devices and equipment.**	PRN3, PRN7, PRN 10, PRN13, PRN22, PRN23, PRN 24	***Practical work* 9-10**	**7-8*th weeks***
5.	**Mathematical support for the design of BM REA. Procedure for certification of medical equipment.**	PRN3, PRN7, PRN 10, PRN13, PRN22, PRN23, PRN 24	***Practical work* 11-12**	**9-10*th weeks***
6.	**A set of tools for automated design of biomedical equipment**	PRN3, PRN7, PRN 10, PRN13, PRN22, PRN23, PRN 24	***Practical work* 13-14**	**11-12*th weeks***
7.	**Scientific and methodological principles of biomedical equipment design. Certification of medical equipment.**	PRN3, PRN7, PRN 10, PRN13, PRN22, PRN23, PRN 24	***Practical work* 15-18**	**13-14*th weeks***
8.	**Basic safety requirements for the design of medical devices. Equipment performance testing**	PRN3, PRN7, PRN 10, PRN13, PRN22, PRN23, PRN 24	***Registration and submission of Calculation and Graphic Work (CGW)***	**15-16*th weeks***
9.	**List of regulatory documents regarding the implementation and operation of medical equipment. Technical documents, their features.**	PRN3, PRN7, PRN 10, PRN13, PRN22, PRN23, PRN 24	***Abstract,Test***	**17-18*th weeks***

4. Training materials and resources

Basic literature:

1. METHODS AND MEANS OF PHYSIOTHERAPY: lecture notes for the study of the credit module of the discipline "Biothermodynamics and mass transfer-2. Methods and means of physiotherapy »[Electronic resource]: textbook. way. for students. specialty 163 - "Biomedical Engineering", specialization "Medical Engineering" / KPI. Igor Sikorsky; structure. MF Bogomolov, VV Shlykov - Electronic text data (1 file ___ MB). - Kyiv: KPI named after Igor Sikorsky », 2020. - 248 p.
2. W. Mark Saltzman. BIOMEDICAL ENGINEERING. Bridging Medicine and Technology/ CAMBRIDGE UNIVERSITY PRESS.Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, São Paulo, Delhi, Dubai, Tokyo, 2019.- 673p.

Additional literature:

3. Laser and its Medical Applications / W. Brooks та ін. Scientific Advancement / ред.: A. Raizada, N. Srivastava. Zittau : Weser Books, 2022. С. 19–34.
4. 2. Mahamood R. Laser Basics and Laser Material Interactions. Laser Metal Deposition Process of Metals, Alloys, and Composite Materials. 2018. С. 11–35.
5. 3. Patil U., Dhami L. Overview of lasers. Indian Journal of Plastic Surgery. 2008. Т. 41. С. 110–113.
6. 4. Edwards W. LASER Light Amplification by the Stimulated Emission of Radiation. NASA Langely Research Center. Tutorials. 31.10.2022. URL: https://lasersdbw.larc.nasa.gov/tutorials/laser/.
7. 5. Das N. Fundamentals and laser-tissue interaction physics in dentistry.. INTERNATIONAL JOURNAL OF CURRENT MEDICAL AND PHARMACEUTICAL RESEARCH. 2023. Т. 9, вип. 1. С. 344–351.
8. 6. Steiner R. Laser-Tissue Interactions. Laser and IPL Technology in Dermatology and Aesthetic Medicine. Springer, 2008. С. 23–36.
9. 7. 3 - The response of tissue to laser light / A. Douplik та ін. Lasers for Medical Applications - Diagnostics, Therapy and Surgery. Woodhead Publishing Limited, 2013. С. 47–109.
10. 8. Ali Ansari M., Erfanzadeh M., Mohajerani E. Mechanisms of Laser-Tissue Interaction: II. Tissue Thermal Properties. Journal of LASERS in Medical Sciences. 2013. Т. 4, вип. 3. С. 99–106.
11. 9. Insero G., Romano G. Laser photo-induced effects: a focus on the photothermal interaction. Energy for Health. 2024. Т. 24.
12. 10. Chilakamarthi U., Giribabu L. Photodynamic Therapy: Past, Present and Future. The Chemical Record. 2017. Т. 17, вип. 4. С. 775–802.
13. 11. Current Strategies for Tumor Photodynamic Therapy Combined With Immunotherapy / J. Hua та ін. Sec. Cancer Immunity and Immunotherapy. 2021. Т. 11.
14. 12. Cross S. Physical Enhancement of Transdermal Drug Application: Is Delivery Technology Keeping up with Pharmaceutical Development?. Current drug delivery. 2004. Т. 1. С. 81–92.
15. 13. Wong T. Electrical, magnetic, photomechanical and cavitational waves to overcome skin barrier for transdermal drug delivery. Journal of Controlled Release. 2014. Т. 193. С. 257–269.
16. 14. Jeon D. Review on practical photoacoustic microscopy. Photoacoustics. 2019. Т. 15.
17. 15. Widyaningrum R. The Influence of Diode Laser Intensity Modulation on Photoacoustic Image Quality for Oral Soft Tissue Imaging. Journal of LASERS in Medical Sciences. 2020. Т. 11. С. 92–100.
18. 16. Barbosa R., Mendes P. A Comprehensive Review on Photoacoustic-Based Devices for Biomedical Applications. Sensors. 2022. Т. 22. С. 9541.
19. 17. Khalkhal E. The Evaluation of Laser Application in Surgery: A Review Article. Journal of LASERS in Medical Sciences. 2019. Т. 10. С. 104–111.
20. 18. Razoki B. Laser in dermatology: past, present and future. Cmtcovm. Pedia. 21.10.2023. URL: https://www.cmtc.nl/en/pedia/ovm/laser-in-dermatology-past-present-and-future/#:~:text=Laser%20technologies%20have%20paved%20the%20way%20for%20both,applications%20and%20future%20of%20this%20special%20treatment%20modality.
21. 19. Ngan V. Lasers in dermatology. DermNet. URL: https://dermnetnz.org/topics/lasers-in-dermatology#:~:text=Picosecond%20Nd%3AYAG%20and%20alexandrite%20lasers%20have%20been%20found,cosmetically%20disabling%20hair%20due%20to%20hypertrichosis%20or%20hirsutism.
22. 20. Aickara D. Low-level laser therapy for the treatment of male and female-pattern hair loss: A review of literature. Skin, Appendages, and Stem Cell Biology. Т. 139 : 2019. С. 154.
23. 21. Qayym H., Liaqat S. Laser as an innovative tool, its implications and advances in dentistry: A systematic review. Journal of Photochemistry and Photobiology. 2022. Т. 12.

24. 22. Feng Z., Yuan R. Effect of Er:YAG Laser Irradiation on Preventing Enamel Caries: A Systematic Review and Meta-Analysis. International Dental Journal. 2024. T. 74. C. 679–687.

Electronic resources:

1. http://info-library.com.ua/books-text-4072.html.
2. http://www.twirpx.com.
3. **Electronic campus. Teacher MF Bogomolov.**
4. http://info-library.com.ua/books-text-4072.html.
5. http://www.twirpx.com.
6. http://ela.kpi/handle/123456789/7739 .
7. http://info-library.com.ua/books-text-4072.html .
8. http://ela.kpi/handle/123456789/11560.

Educational content

5. Methods of mastering the discipline (educational component)

Information (by sections, topics) about all classes (lectures, practical, seminar, laboratory):

Names of sections and topics	Number of hours					
	Total	including				
		Lectures	Practical (seminar)	Computer workshops	Laboratory	Independent student work
1	2	3	4	5	6	7
Section 1. Classification of modern medical equipment.						
Theme 1.1. General concepts about the development of medical devices.	11	4	2			5
Theme 1.2. Basic medical and technical requirements for the development of medical devices.	11	4	2			5
Theme 1.3. System analysis of biomedical equipment design.	12	4	3			5
Theme 1.4. Technical support for the development of medical devices.	13	6	2			5
Total by Section 1	**47**	**18**	**9**			**20**
Section 2. The main characteristics of the equipment of IR-therapy.						
Theme 2.1. Mathematical support for the design of BM REA.	12	4	2			6
Theme 2.2 Complex of means of automated design of biomedical equipment.	11	1	4			6
Theme 2.3. Scientific and methodological	12	4	2			6

Names of sections and topics	Number of hours					
	Total	including				
		Lectures	Practical (seminar)	Computer workshops	Laboratory	Independent student work
principles of designing biomedical equipment.						
Theme 2.4. Basic safety requirements for the design of medical devices.	13	1	3			9
Theme 2.5. List of normative documents on introduction and operation of medical equipment.	12	4	2			6
Total by Section 2	**60**	**18**	**9**			**33**
Modular control work	5					5
Test	8					8
Total hours	**120**	**26**	**28**	**–**	**–**	**66**

Recommendations for mastering training sessions (in the form of a detailed description of each lesson and planned work):

Lectures

List of didactic tools for lectures: Lecture notes, projection multimedia equipment; Power Point presentation.

№ s/n	Title of the lecture topic and list of main questions (list of didactic tools, references to literature and tasks on ISW)	Hours
1	**System analysis of design. General provisions. Automated design systems for biomedical equipment. Classification of CAD group for design of biomedical equipment.** Features of the system of automatic design of biomedical equipment. A set of design tools. Necessary subdivisions of design organizations. The main purpose of the application of systems for automatic design of biomedical equipment. Technical means, parameters and characteristics of systems of automatic design of biomedical equipment. Basic principles of creating systems for automatic design of biomedical equipment . **Literature [3,c.41-49;5,c.31-45;10,c.34-74;12,c.40-76].** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources **[4,c.34-78;8,c.26-52;13,c.47-59].**	**2**
2	**Technical support of CAD. Principles of construction and operation of CAD for design of biomedical equipment. The list of the basic questions.** The principle of system unity of functioning of CAD of biomedical equipment. Principles of completeness, development, compatibility, standardization and inventory, inclusion and accumulation of experience. Mathematical formulation of the problem of designing biomedical equipment, choice of numerical design methods, development of design algorithm, mathematical models and methods. **Literature [8, c.19-36; 4, c.26-45; 6, c. 92-106; 13, c.19-27].** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources **[8,c.34-68;9,c.56-97;16,c.47-105].**	**2**
3	**Mathematical support of CAD. Functional description of biomedical design objects.**	**2**

	Features of mathematical software support of biomedical equipment. Software, information support, linguistic support. Features of software use in the design of printed components and components of biomedical equipment. Application of modern software products of automated design, production of technical and technological documentation during the introduction into production of the proposed design solutions. **Literature [5, c.75-98; 9, c.46-83; 13, c.67-122].** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources **[1,c.34-67;17,c.67-109;19,c.34-79].**	
4	**CAD software for biomedical purposes. General software. Specialized software. Generalized algorithm of automated design of biomedical equipment.** Features of the generalized algorithm of automated design of biomedical equipment, interaction of program-methodical complexes and program-technical complexes. The set of interactions of all structural elements of CAD biomedical equipment. Organized sequence of automated and non-automated operations for the design of biomedical equipment. **Literature [8, c.97-140;11, c.96-126; 21, c.76-105].** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources **[6,c.45-77;16,c.34-67;19,c.34-92].**	**4**
5	**CAD information support. Complexes of CAD technical means, their structure, characteristics and features for design of biomedical equipment.** Requirements for information support of biomedical equipment CAD. The range of properties, parameters and characteristics of CAD information support as a technical system. Features of problem-oriented complexes of technical means of automated design of biomedical devices and complexes. Functional groups of general-purpose technical means for designing biomedical equipment. **Literature [6, c.55-78; 11, c.66-98; 20, c.71-129].** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources **[5,c.44-76;8,c.28-49;12,c.56-87;18,c.75-107;18,c.61-84].**	**2**
6	**Functional and constructive hierarchy of biomedical equipment design.** Features of object-oriented methods of designing biomedical equipment. Mathematical models of processes carried out in biomedical equipment. Probable characteristics of a set of random variables in the process of designing biomedical equipment. Basic structural and structural modules of the first level (SCM1) any biomedical equipment, characteristics of cells and microassemblies, functional units of biomedical purpose. **Literature [1, c. 44-96; 3, c.55-97; 16, c.112-139; 17, c.105-123].** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources **[4,c.44-67;8,c.106-118;11,c.74-109].**	**4**
7	**Features of REA structures for biomedical purposes.** Features of the constructive hierarchy of biomedical equipment, constructions of the second level of complexity, block frameworks. Influence of external destabilizing mechanical and climatic factors. Characteristics of vibration shock resistance systems and temperature stabilization of biomedical equipment. **Literature [5, c.97-114; 8, c.106-123; 11, c.96-117].** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources **[4,c.55-87;10,c.124-137;16,c.84-91].**	**4**
8	**Purpose and general characteristics of the design system of structural modules of biomedical equipment Dip Trace.** Features of creating a component seat in the Dip Trace system. Creating images of symbols of circuit elements in the Dip Trace system. Description of the library of components of basic electrical circuits of biomedical equipment in the Dip Trace system. Features of automatic tracing of printed conductors of electronic modules of biomedical equipment in the Dip Trace system. **Literature [7,c.65-98; 11, c.76-93; 18, c.117-134].** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources **[2,c.34-67;15,c.79-123;17,c.104-129].**	**2**

9	**Purpose and general characteristics of the design system of 3-D structures of biomedical equipment Solid Works Simulation.** Production and printing of drawings of the printed circuit board and the printed circuit board of biomedical equipment in the Solid Works Simulation system. Production of technological documents for the design of biomedical equipment in the system Solid Works Simulation. Features of designing structures of biomedical devices and preparation of the necessary technological documentation for implementation in production by means of the Solid Works Simulation design system. **Literature [11, c.129-135; 13, c. 91-103; 16, c.120-137; 18, c.93-105; 120, c .112-130].** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources **[6,c.126-137;17,c.89-107;20,c.114-129].**	**4**
Total hours		**26**

Practical The main tasks of the series of practical classes: consolidation in practice of the main provisions of the discipline " ***Development and operation of physiotherapeutic medical devices*** " and basic laboratory methods, schematic diagrams of laboratory equipment, to master practical skills of calculating parameters by performing specially formulated tasks and real circuit design options for printed modules and equipment, which is actually projected in the bachelor's theses of students. The practical lesson includes control of knowledge, skills and abilities, solving real problems of designing biomedical equipment with their discussion, solving control problems, their verification and evaluation.

Grades received by the student for individual practical classes are registered in the journal of classes of the study group and are taken into account when determining the final grade (rating) for this discipline.

№ s/n	Class Subject Name	Hours
1	Basic documents for the design of medical devices.	**4**
2	System analysis of biomedical physiotherapy equipment design.	**4**
3	Technical support of design, stages of functioning of medical equipment for physiotherapeutic purposes.	**3**
4	Mathematical support in the design, development and operation of physiotherapeutic medical devices.	**4**
5	A set of tools for automated design of biomedical equipment for physiotherapy.	**4**
6	Information support in the design, development and operation of physiotherapeutic medical devices.	**2**
7	Scientific and methodological principles of designing biomedical equipment.	**2**
8	Automated design systems for biomedical equipment **Dip Trace**.	**3**
9	**Solid Works Simulation** automated design systems for biomedical equipment	**2**
Total hours		**28**

Individual tasks

From this credit module the individual task in the form - **Modular test work (MTW)** is planned.

The main goals of the individual task:

Modular test work (MTW) is an ongoing control measure that covers the practical skills of using science tools to quantify, analyze and evaluate functional systems and processes of interacting natural and artificial systems, which will: research, develop, apply, improve and implement solutions, tools and methods of engineering and precision sciences, as well as methods and technologies of medical and bioengineering to solve problems related to human health and quality of life; solve problems and problems of bioengineering for artificial creation or replacement of cells, tissues and organs of the human body, for artificial improvement and correction of their functions, development on this basis of laboratory analytical diagnostic technologies, tools and systems.

Test tasks for modular test work are added to the working curriculum.

Abstract is a current control measure, which involves solving a specific practical educational problem based on the theoretical scope of the discipline "***Development and operation of physiotherapeutic medical devices*** " using known and self-studied theoretical material for the design and construction of modern laboratory optoelectronic analytical devices for general purposes. Much of this work is graphic material, which is performed in accordance with current regulations and with the mandatory use of computer graphics, if defined by the task, and the use of modern software systems for designing biomedical equipment for laboratory analytical purposes. ***Abstract*** covers practical skills of modern tools and technologies of search, processing and analysis of information, research related to biomedical engineering interdisciplinary areas, critically analyze the results of their own research and the results of other researchers in the context of the whole complex of modern knowledge. Much of this work is graphic material, which is performed in accordance with applicable regulations and with the mandatory use of computer graphics, if defined by the task, and the use of modern software systems for designing laser and optoelectronic diagnostic devices for analytical purposes. Tests, as well as calculation work, may provide some illustrative material.

The main objectives of the individual task: ***Abstract*** is a task that involves solving a specific practical educational problem based on the theoretical scope of the discipline ***"Development and operation of physiotherapeutic medical devices"*** using known and self-studied theoretical material for the design and construction of modern laser laboratory analytical general purpose devices. Much of this work is graphic material, which is performed in accordance with applicable regulations and with the mandatory use of computer graphics, if defined by the task, and the use of modern software systems for designing laser and optoelectronic diagnostic devices for analytical purposes. Tests, as well as calculation work, may provide some illustrative material.

Approximate topics (name of individual task):

1. **Classification of modern laser and optoelectronic devices.**
2. **Methods of pumping lasers, creating an inversion, the population of energy levels.**
3. **Features of quantum amplification and generation of laser radiation.**
4. **Interaction of laser radiation with biological objects.**
5. **Features of interaction of laser radiation with small particles.**
6. **Interaction of laser radiation with medium and large particles.**
7. **Features of scattering of laser radiation from blood elements.**
8. **Mathematical model of interaction of laser light with small particles.**
9. **Mathematical methods of analysis of optical characteristics of various objects.**
10. **Modeling of scattering indicator for biological objects.**
11. **Computer modeling of the processes of interaction of laser radiation with blood cells.**
12. **Determination of microparticle parameters by computer processing of scattering indicator.**
13. **Computer methods of analysis of laser scattering processes.**
14. **Influence of microparticle parameters on laser scattering indicator.**
15. **Features of scattering of laser radiation from human blood.**
16. **Computer methods for modeling the scattering of laser radiation from biological objects.**
17. **Computer methods of processing the speckle structure of laser radiation.**

Topics of individual tasks are added to the work program. (Appendix №2)

Extracurricular activities It is planned to study at least two field trips within the framework of studying the discipline - on the basis of modern medical medical rehabilitation centers, as well as participation in Exhibitions of modern medical instrument making, in particular "**Healthcare 2022 and 2023",** etc.

Distance learning platform: For more effective communication in order to understand the structure of the discipline ***"Development and operation of physiotherapeutic medical devices"*** and master the material e-mail, distance learning platform **"Sikorsky"** based on the **Moodle KPI-**

Telecom system and service for online meetings **Zoom** are used, through which it is possible to : - simplify the placement and exchange of educational material; - provide students' feedback on learning objectives and content of the discipline; - evaluate students' learning tasks; - maintain the account of performance by students of the plan of academic discipline, the schedule of performance of educational tasks and their estimation.

6. Independent student work (ISW)

Types of independent work *(preparation for classroom classes, calculations based on primary data obtained in laboratory classes, problem solving, essay writing, calculation work, homework, etc.):* ***Independent work***

№ s/n	Names of topics and questions submitted for self-study and references to educational literature	Hours ISW
1	**Theme 1.1. General concepts of medical equipment. Classification of modern medical equipment. General concepts of medical equipment.** Introduction to the discipline. General concepts of features of medical equipment for further action in diseases of the cardiovascular system of the human body, basic terms and definitions. Electronic devices of therapy in medical equipment and their classification. The main tasks of design and requirements for modern medical equipment. Different distributions of therapeutic equipment by functional complexity. **Literature [5,c.31-53;8,c.31-45;9,c.21-54;11,c.41-56].** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources **[4,c.34-78;8,c.26-52;13,c.47-59].**	**8**
2	**Theme 1.2. Apparatus for low-frequency magnetic field therapy.** General purpose equipment. Equipment and methods of application of low-magnetic field therapy. Apparatus for woofer magnetic therapy "Pole 1". The effect of the woofer field system on the human body. Characteristics of the ability of human skin to absorb the magnetic field. Components of modern devices for magnetic field therapy, their features and purpose. Application of magnetic therapy and rehabilitation in clinical medicine. Possibility of treatment of oncological diseases and diseases of the cardiovascular system. **Literature [8, c.19-36; 4, c.26-45; 6, c. 92-106; 13, c.19-27].** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources **[8,c.34-68;9,c.56-97;16,c.47-105].**	**8**
3	**Theme 1.3.Apparatus for therapy with direct electric current and field.** Features of protocols of general procedures of physiotherapy. The effect of aeroionotherapy. Apparatus for electroaerosol therapy. The main modern ways of influencing the electric field on the human body and the heart. Apparatus of therapy in inpatient and outpatient settings, indication and transmission of information during visualization and registration, the main criteria for choosing the type of transmission of information. **Literature [5, c.75-98; 9, c.46-83; 13, c.67-122].** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources **[1,c.34-67;17,c.67-109;19,c.34-79].**	**8**
4	**Theme 1.4. Electroaerosol generator on the principle of injection.** The principle of operation of the generator. Features of the schematic diagram. Medical methods of application of the generator of electroaerosols. The main characteristics of modern aerosol generators for the treatment of human cardiovascular diseases. Medical devices for the study of the characteristics and	**8**

№ s/n	Names of topics and questions submitted for self-study and references to educational literature	Hours ISW
	measurement of air flow rate, volume, gas concentration and respiratory rate. Modern schemes for measuring the basic parameters and characteristics of aerosols with different distributions of trace elements. **Literature [8, c.97-140;11, c.96-126; 21, c.76-105].** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources **[6,c.45-77;16,c.34-67;19,c.34-92].**	
5	**Theme 2.1. Physical bases of action of RF oscillations on body tissues.** Basic methods of applying RF oscillations. Features of diathermy and RF electrosurgery. Features of measuring the parameters of RF oscillations for use in physiotherapy of diseases of the cardiovascular system, as well as in correcting the state of the immune system of the human body. Devices for measuring voltage and distribution of electromagnetic waves in the air during treatment. **Literature [6, c.55-78; 11, c.66-98; 20, c.71-129].** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources **[5,c.44-76;8,c.28-49;12,c.56-87;18,c.75-107;18,c.61-84].**	**8**
6	**Theme 2.2. Darsonvalization and physiotherapy with overtone frequency current.** Features of devices for current therapy above the tonal frequency. Features of installation for darsonvalization on application of currents of supertonal frequency at physiotherapy, formation of techniques of effective correction of immune system of a human body. Block diagram of modern devices for adjusting the immune system of the human body. **Literature [1, c. 44-96; 3, c.55-97; 16, c.112-139; 17, c.105-123].** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources **[4,c.44-67;8,c.106-118;11,c.74-109].**	**13**
7	**Theme 2.3. Apparatus for UHF and microwave therapy.** Features of pulsed and continuous UHF and microwave devices. Medical applications of DMH and SMH therapeutic devices. Features of modern physiotherapy systems with the help of electromagnetic waves of different power in the range of DMH and SMH therapy. Possibilities and problems of traditional microwave equipment for physiotherapy. The principle of formation of effective distribution of electromagnetic waves at carrying out medical procedures for increase of level of immune system of an organism of patients with cardiovascular diseases. Advantages and disadvantages. **Literature [5, c.97-114; 8, c.106-123; 11, c.96-117].** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources **[4,c.55-87;10,c.124-137;16,c.84-91].**	**13**
Total hours		**66**

Policy and control

7. Policy of academic discipline (educational component)

Attending classes

Attendance at lectures is optional. Attending practical classes is desirable, as they are used to write express tests / tests, as well as to represent practical work.

The grading system is focused on obtaining points for student activity, as well as performing tasks that are able to develop practical skills and abilities.

Control measures missed

Missed control measures (presentation of practical work) must be practiced in the mentioned classes, provided that the task is scheduled for the current lesson, or in consultations.
Neglecting of writing a module test and express test are not fulfilled.
Calculation and graphic work, which is submitted for inspection in violation of the deadline, is evaluated with a decrease in the number of weight points.

Incentive points

Encouragement points	
Criterion	*Weight points*
Improving practical work	*1 points (for each practical work)*
Passing distance courses on topics that are agreed with teachers	*5 points*
Registration of scientific work for participation in the competition of student scientific works	*10 points*
Writing abstracts, articles, participation in international, national and / or other events or competitions on the subject of the discipline	*5 points*
*Timely writing of **MTW***	*5 points*
*Timely delivery of the **test***	*10 points*

Academic integrity

*The policy and principles of academic integrity are defined in Section 3 of the Code of Honor of the **National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute".** Read more:* https://kpi.ua/code.

Norms of ethical behavior

*Normative principles of behavior of students and employees, defined in sections 2 of the Code of Honor of the **National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"**. Read more: https://kpi.ua/code.*

Procedure for appealing the results of control measures

Students have the opportunity to raise any issue related to the control procedure and expect it to be addressed according to predefined procedures.

*The student has the right to appeal the results of the control measure according to the approved provision on appeals in the **National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"** (approved by the order №NON/128/2021 from 20.05.2021) - https://osvita.kpi.ua/index.php/node/182*

Inclusive education

*The discipline **"Development and operation of physiotherapeutic medical devices"** can be taught to*

most students with special educational needs, except for students with severe visual impairments that do not allow to perform tasks using personal computers, laptops and / or other technical means.

Distance education

*Distance education takes place through the **Sikorsky Distance education Platform «Sikorsky».***

Distance education through additional online courses on certain topics is allowed subject to agreement with students. If a small number of students wish to take an online course on a specific topic, studying the material with such courses is allowed, but students must complete all the tasks provided in the discipline.

The list of courses is offered by the teacher after the students have expressed a desire (because the bank of available courses is updated almost every month).

The student provides a document confirming the completion of the distance course (in the case of a full course) or provides practical tasks from the distance course and subject to an oral interview with the teacher on the topics can receive grades for control measures provided for the studied topics (express control / test tasks, practical work).

Performance of practical works, and also performance of settlement and graphic work, is carried out during independent work of students in a remote mode (with a possibility of consultation with the teacher through e-mail, social networks).

Learning a foreign language

Teaching in English is carried out only for foreign students.

On request of students, it is allowed to study the material with the help of English-language online courses on topics that correspond to the topics of specific classes.

8. Monitor and evaluate the system of evaluation of learning outcomes (Rating System of Evaluation)

Evaluation system (current control):

№ s/n	Control measure	%	Weight points	Number	Total
1.	Express control works / test tasks	14	2	7	14
2.	Execution and test of practical works	24	2	12	24
3.	Execution and test of control works	27	3	9	27
4.	Modular control work (MCW)	15	15	1	15
5.	Abstract work (AW)	20	20	1	20
6.	Test work[1]	80	80	1	80
	Total				100

*The applicant receives a positive credit score for the results of the semester, if he has a final rating for the semester of at least 60 points and has met the conditions of admission to the semester control, which are determined by the **RSE (Rating System of Evaluation).***

With applicants who have met all the conditions of admission to the test and have a rating of less than 60 points, as well as with those applicants who want to increase their rating, in the last scheduled lesson in the semester, the teacher conducts semester control in the form of test or interviews.

After performing the test, if the score for the test is higher than the rating, the applicant receives a score based on the results of the test.

*If the grade for the test is lower than the rating, a "hard" **RSE** is used - the previous rating of the applicant (except for points for the semester individual task) is canceled and he receives a grade based*

[1] *Враховується в суму рейтингу разом з оцінкою за РГР у разі, якщо студент не набрав 60 балів за семестр або він хоче покращити свою оцінку.*

on the results of the test. This option forms a responsible attitude of the applicant to the decision to perform the test, forces him to critically assess the level of his training and carefully prepare for the test.

***Calendar control (CC)** - is performed twice a semester as monitoring of the current state of compliance with syllabus requirements.*

The purpose of calendar control is to improve the quality of student learning and monitor the implementation of the schedule of the educational process by students.

Criterion			The first CC	The second CC
Deadline of calendar controls			8th week	14th week
Conditions for obtaining a positive result from the calendar control	Current rating		≥ 24 points	≥ 40 points
	Execution of practical work	PW № 1- 6	+	+
		PW № 7-12	-	+
	Express control works / test tasks	At least 4 of any lectures	+	-
		At least 8 of any lectures	-	+
	Modular control work	Estimated MCW	-	+
	Abstract work	Estimated AW	-	-

In case of detection of academic poor quality during training - the control measure is not credited.

Semester certification of students

Mandatory condition for admission to the test		Criterion
1	Current rating	RD ≥ 42
2	Obtaining a positive assessment for the performed Abstract work	More than 8 points
3	All practical works are tested	More than 14 points
4	Writing at least 6 express tests / tests	More than 6 points

*The results are announced to each student separately in the presence or remotely (by e-mail). Also recorded in the system **"Electronic Campus".***

Optional conditions for admission to closure:

1. *Activity in practical classes.*
2. *Activity in laboratory classes.*
3. *Positive result of the first attestation and the second attestation.*
4. *Attending of 50% of lectures.*

Table of translation of rating points to grades on a university scale:

Number points	Assessment on the university scale
100-95	Perfect / Відмінно
94-85	Very good / Дуже добре
84-75	Good / Добре
74-65	Satisfactorily / Задовільно
64-60	Enough / Достатньо
Less 60	Unsatisfactorily / Незадовільно
Admission conditions are not met	Not allowed / Не допущено

Procedure for appealing the results of control measures: Students have the opportunity to raise any issue related to the control procedure and expect it to be addressed according to predefined procedures. Students have the right to challenge the results of the control measures, but it is obligatory to explain, with which criterion they do not agree according to the assessment letter and

/ or comments.

Additional information about the exam / test / interview:

The student has the right to improve their scores on the module test in the case of its timely writing in the scheduled class. Students are not allowed to use lecture notes or mobile devices during the test. It is allowed to use computer technology and educational and methodical support for practical classes.

9. Additional information on the discipline (educational component)

*The list of questions for preparation for **Calculation and Graphic Work (CGW)**, and also for preparation for credit is given in **Appendix 2.***

Distance education through additional online courses on certain topics is allowed subject to agreement with students. If a small number of students wish to take an online course on a specific topic, studying the material with such courses is allowed, but students must complete all the tasks provided in the discipline.

The list of courses is offered by the teacher after the students have expressed a desire (because the bank of available courses is updated almost every month).

The student provides a document confirming the completion of the distance course (in the case of a full course) or provides practical tasks from the distance course and subject to an oral interview with the teacher on the topics can receive grades for control measures provided for the studied topics (express control / test tasks, practical work).

The list of questions that are submitted for semester control for Modular Control Work (MCW), as well as for preparation for the test:

1. Therapeutic generators of liquid drugs. Features of work, schemes, characteristics.
2. Features of electrotherapeutic high-frequency equipment. Basic schemes, characteristics.
3. Physical basis of the action of high-frequency oscillations on the human body and biotissues. Useful effects, advantages, disadvantages.
4. Therapeutic devices for diathermy. Features of work, schemes, characteristics.
5. Therapeutic devices for electrosurgery. Features of work, schemes, characteristics.
6. Therapeutic devices for darsonvalization and treatment with current above the tonal frequency. Features of work, schemes, characteristics.
7. Therapeutic devices for inductothermy. Features of work and designs of inductors. Pros and cons.
8. Modern devices for UHF therapy. Features of work, schemes, characteristics.
9. Modern devices for pulsed UHF therapy. Features of work, schemes, characteristics.
10. Modern devices for DMV therapy. Features of work, schemes, characteristics.
11. Modern devices for SMV therapy. Features of work, schemes, characteristics.
12. Modern ultrasonic therapeutic devices. Pros and cons. Features of work, schemes, characteristics.
13. Modern devices for endoscopy and surgery using fiber-optic optical fibers. Features of work, schemes, characteristics.
14. Modern laparoscopic surgical devices for anemic surgery. Features of the optical scheme, advantages and disadvantages.
15. Basic requirements for electrical safety of electromedical equipment.
16. Protection of medical equipment from high voltage. Classes of execution of devices and devices with external power supply.
17. Modern devices for ultraviolet radiation therapy. Features of work, schemes, characteristics.

18. Modern devices for infrared radiation therapy. Features of work, schemes, characteristics.

19. Modern devices for therapy with visible optical radiation. Features of work, schemes, characteristics.

20. Modern devices for therapy with monochromatic optical radiation. Features of work, schemes, characteristics.

21. Laser therapeutic devices. Schemes, characteristics.

22. The use of UV lasers in medicine. Schemes, characteristics.

23. The use of infrared lasers in medicine. Schemes, characteristics.

24. Influence of UV and IR radiation on biological objects.

25. The use of lasers for irradiation of human blood. Schemes, characteristics.

26. Modern laser scalpels on CO2 and solid-state lasers.

27. Fiber-optic medical endoscopes. Constructions, characteristics.

28. The use of lasers in ophthalmology. Schemes, constructions.

29. The use of lasers in oncology. Schemes, constructions.

30. The use of lasers for therapy. Schemes, constructions.

31. The use of lasers for disease diagnosis. Schemes, constructions.

32. The use of lasers in surgery. Schemes, constructions.

33. The use of lasers for the treatment of human skin diseases, cosmetology.

34. The use of He-Ne lasers for the treatment of cardiovascular diseases. Schemes, characteristics.

Ability to enroll in certificates of distance learning courses: Distance education through online courses in the **Moodle** system on certain topics is an allowed subject to discuss with students. If a small number of students want to take an online course on a particular topic, studying the material with such courses is allowed, but students must complete all the tasks provided in the discipline (practical work, modular control work, calculation and graphic work). The list of distance courses is given on the website of the **Department of Biomedical Engineering "KPI. Igor Sikorsky": http://bmi.fbmi.kpi.ua/non-formal-education.**

10. *Appendices to the syllabus of the discipline "Development and operation of physiotherapeutic medical devices"*

Appendix 1. Program learning outcomes (extended form)

As a result of studying the discipline ***"Development and operation of physiotherapeutic medical devices"*** students will be able to:

Learning outcomes		**Correspondence of learning outcomes to the competencies of the SVO [6]**	
		General Competence (soft skills)	**Special competence (professional)**
PRN 3	Manage complex activities or projects, be responsible for making engineering decisions in unpredictable conditions, conduct feasibility and safety assessments of projects (Reinforcement).	ZK 1 Ability to apply knowledge in practical situations. (Reinforcement).	FK 2 Ability to provide engineering and technical expertise in the planning, development, evaluation, and specification of medical equipment

			(Reinforcement).
PRN 7	Manage complex activities or projects, be responsible for making engineering decisions in unpredictable conditions, conduct feasibility and safety assessments of projects (Reinforcement).	ZK 2 Knowledge and understanding of the subject area and understanding of professional activity (Reinforcement).	FK 7 Ability to plan, design, develop, install, operate, maintain, service, control and coordinate the repair of devices, equipment and systems for prevention, diagnosis, treatment and rehabilitation used in hospitals and research institutes (Reinforcement).
PRN 10	Be able to plan, organize, direct and control medical and bioengineering systems and processes (Reinforcement).	ZK 4 Skills in using information and communication technologies (Reinforcement).	FK 2 Ability to provide engineering and technical expertise in the planning, development, evaluation, and specification of medical equipment (Reinforcement).
PRN 13	Be able to analyze signals transmitted from organs to devices and process diagnostic information (signals and images) (Reinforcement).	ZK 4 Skills in using information and communication technologies (Reinforcement).	Formulate logical conclusions and substantiated recommendations regarding the evaluation, operation and implementation of modern physiotherapeutic medical devices, medical and bioengineering tools and methods.
PRN 22	Knowledge of general principles and structure of complex biological systems, including the human body and its functions from the perspective of a systemic approach and their utilization in biomedical engineering, as well as basic methods and tools used for quantitative assessment of physiological system functioning (Reinforcement).	ZK 1 Ability to apply knowledge in practical situations. (Reinforcement).	FK 7 Ability to plan, design, develop, install, operate, maintain, service, control and coordinate the repair of devices, equipment and systems for prevention, diagnosis, treatment and rehabilitation used in hospitals and research institutes (Reinforcement).
PRN 23	Development and implementation of modern diagnostic and therapeutic methods associated with the use of biotechnology, computer, and nanotechnology through the improvement of technical elements of medical devices and	ZK 2 Knowledge and understanding of the subject area and understanding of professional activity (Reinforcement).	FK 2 Ability to provide engineering and technical expertise in the planning, development, evaluation, and specification of medical equipment (Reinforcement).

	systems, as well as medical products, in the process of professional activity (Reinforcement).		
PRN 24	Being able to consider historical, social, environmental, ethical, legal, economic aspects, requirements of labor protection, industrial hygiene, and fire safety when forming technical solutions, taking into account the strengthening and preservation of personal and public health (Reinforcement).	ZK 13 The ability to preserve and multiply the moral, cultural, scientific values and achievements of society based on understanding the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society and in the development of society, technology and engineering, to use various types of physical activity for active recreation and leading a healthy lifestyle (Reinforcement).	FK 12 Ability to ensure and monitor compliance with safety and biomedical ethics when working with medical equipment (Reinforcement).

Appendix 2. Topics of individual tasks to check the level of learning material in the performance of Abstract:

1. Therapeutic light-optical devices of the UV range. Features of work, schemes, characteristics.
2. Therapeutic devices of the X-ray range. Features of work, schemes, characteristics.
3. Therapeutic radiological devices. Features of work, schemes, characteristics.
4. Therapeutic devices for electrohydrotherapy. Features of work, schemes, characteristics.
5. Therapeutic devices for galvanization. Features of work, schemes, characteristics.
6. Therapeutic devices for drug electrophoresis. Features of work, schemes, characteristics.
7. Therapeutic devices for electrical stimulation. Features of work, schemes, characteristics.
8. Therapeutic devices for electron anesthesia. Features of work, schemes, characteristics.
9. Therapeutic devices for electrosleep. Features of work, schemes, characteristics.
10. Apparatus for electroshock therapy. Features of work, schemes, characteristics.
11. Apparatus for defibrillation of the human heart. Features of work, schemes, characteristics.
12. Apparatus for diadynamic current therapy. Features of work, types of signals, schemes, characteristics.
13. Therapeutic devices for franklinization. Features of work, schemes, characteristics.
14. Therapeutic devices for magnetic therapy. Features of work, schemes, characteristics.
15. Therapeutic devices for the treatment of interference currents. Features of work, schemes, characteristics.
16. Apparatus for therapy with modulated sinusoidal currents. Features of work, schemes, characteristics.
17. Apparatus for current therapy with noise spectrum. Features of work, schemes, characteristics.
18. Therapeutic devices for local darsonvalization. Features of work, schemes, characteristics.
19. Therapeutic devices for high-frequency electrosurgery. Features of work, schemes, characteristics.
20. Therapeutic devices for general darsonvalization. Features of work, schemes, characteristics.

21. The use of laser radiation sources for angioplasty. Features of work, optical schemes, characteristics.
22. Therapeutic equipment for action on human biopotentials. Features of work, radiation sources, schemes, characteristics.
23. Therapeutic devices for the treatment of pulsed and alternating currents .. Features, types of signals, schemes, characteristics.
24. Modern pacemakers. Requirements for construction and materials. Pros and cons.
25. Apparatus for low-frequency magnetic field therapy. Features of work, schemes, characteristics.
26. Apparatus for low-frequency magnetic therapy. Features of work, schemes, characteristics.
27. Therapeutic devices for treatment with a constant electric field and air ions. Features of work, schemes, characteristics.
28. Apparatus for aeroionotherapy. Features of work, schemes, characteristics.
29. Modern devices for franklinization. Features of work, schemes.

Work program of the discipline "Development and operation of physiotherapeutic medical devices" (syllabus):

Compiled *by Associate Professor of Biomedical Engineering,* ***Mykola Bogomolov****.*

Approved by the Department of Biomedical Engineering (protocol № 16___ to 21.08.2024).

Approved by the Methodical Commission of the Faculty of Biomedical Engineering (protocol № 9 to 26.09.2024).[2]

The syllabus template has been approved by the university's methodological council.