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

Department of
biomedical engineering

Modern optoelectronic diagnostic 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, autumn semester*
The scope of discipline	*4 ECTS credits / 120 hours*
Semester control / Control measures	*Test Work, Modular Test Work, Abstract*
Lessons schedule	*According to the schedule on the site https://schedule.kpi.ua/*
Language of instruction	*English, Ukrainian*
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=2615

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 "* ***Modern optoelectronic diagnostic 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.*

Teaching methods

Lectures *are held using the explanatory-illustrative method, the method of problem statement, interactive method during lectures, which is used to establish a dialogue with the audience.*

Practical classes *are held using:*

1) Reproductive method, through which students consolidate the studied theoretical material and learn to use it in specific scientific problems.

2) Partial search, or heuristic method, which teaches the search for the right ways and methods of solving problems.

3) Interactive method used during practical classes to involve students in problem-solving processes and theoretical facts used for this purpose. Presentation and discussion of the obtained results involves the use of problem-based and interactive teaching methods.

Applicants independently *study the literature, software tools for the design of medical devices and systems, medical monitoring and forecasting systems, Internet metrology systems and diagnostic devices. For original solutions, educational work can grow into scientific research.*

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 to apply knowledge in practical situations (Reinforcement).***
ZK 2	***Knowledge and understanding of the subject area and understanding of professional activity (Reinforcement).***
ZK 9	***Ability to communicate with representatives of other professional groups at different levels (experts from other fields of knowledge/types of economic activity) (Reinforcement).***

ZK12	***Ability to exercise rights and fulfill duties as a member of society, understand the values of a civil (free democratic) society and the need for its sustainable development, supremacy of law, and the rights and freedoms of individuals and citizens of Ukraine. (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 modern optoelectronic diagnostic devices.
	Ability to evaluate and ensure the quality of work performed in the design and operation of modern optoelectronic diagnostic devices.

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

FK 4	***Ability to ensure the technical and functional characteristics of systems and tools used in medicine and biology (for prevention, diagnosis, treatment, and rehabilitation)/ (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 optoelectronic diagnostic devices.
	Ability to apply physical, chemical, biological and mathematical methods in the analysis and modeling of the functioning of modern optoelectronic diagnostic 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 optoelectronic diagnostic devices.
	The ability to conduct experiments according to specified technical and medical methods, perform computer processing, analysis and synthesis of the obtained results when operating modern optoelectronic diagnostic devices.

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 optoelectronic diagnostic devices, medical and bioengineering tools and methods.
	Apply the provisions of regulatory and technical documents that regulate the procedure for product certification and production certification of modern optoelectronic diagnostic devices.
	Be able to use databases, mathematical and software for data processing and computer modeling of modern optoelectronic diagnostic devices.
	Knowledge of methods for studying objects, analyzing and processing experimental data in laboratory research of modern optoelectronic diagnostic 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 optoelectronic diagnostic devices.
	Possession of modern methods for testing the experimental integrity and operability of modern optoelectronic diagnostic devices and determining their optimal characteristics.

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

Subject of the discipline " Modern optoelectronic diagnostic devices". The discipline 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: - teaching methods: communicative, problem-searching, research, explanatory-demonstration, partial-search, method of educational projects; -implemented: lecture courses, seminars and practical classes, computer workshops and laboratory work, course projects, consultations, independent training in library collections, use of Internet resources, application of information and communication technologies (e-learning, online lectures, distance courses), performance of a qualifying diploma work of the bachelor; - 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 ***" Modern optoelectronic diagnostic 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 ***Annex 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 ***" Modern optoelectronic diagnostic 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 *" **Modern optoelectronic diagnostic 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.	**Features of laser methods of biomedical research. Feasibility and safety assessment of projects.**	PRN3, PRN7, PRN 10, PRN13, PRN22, PRN23, PRN 24	***Practical work 1, 2***	***3rd week***
2.	**Interaction of laser radiation with biological objects. The structure of complex biological systems, including the human body.**	PRN3, PRN7, PRN 10, PRN13, PRN22, PRN23, PRN 24	***Practical work 3,4***	***4th week***
3.	**Main types and characteristics of laser radiation sources. Methods of research, analysis and processing of experimental data.**	PRN3, PRN7, PRN 10, PRN13, PRN22, PRN23, PRN 24	***Practical work 5-8***	**5-6*th weeks***
4.	**Types and characteristics of laser transmission paths and systems. Algorithms for analyzing useful signals.**	PRN3, PRN7, PRN 10, PRN13, PRN22, PRN23, PRN 24	***Practical work 9-10***	**7-8*th weeks***
5.	**Optoelectronic laser circuit of a medical interferometric analyzer of bioobjects. Certification features.**	PRN3, PRN7, PRN 10, PRN13, PRN22, PRN23, PRN 24	***Practical work 11-12***	**9-10*th weeks***
6.	**Absorption laser methods of studying blood bioobjects. Signals of the human body and their functional purpose.**	PRN3, PRN7, PRN 10, PRN13, PRN22, PRN23, PRN 24	***Practical work 13-14***	**11-12*th weeks***
	Nephelometric laser	PRN3, PRN7, PRN 10,	***Practical work***	**13-14*th weeks***

7.	**analyzers of biological objects. Service and maintenance.**	PRN13, PRN22, PRN23, PRN 24	**15-18**	
8.	**Multiparametric laser cytometry. Experimental verification of the functioning of physiological systems.**	PRN3, PRN7, PRN 10, PRN13, PRN22, PRN23, PRN 24	***Registration and submission of Home Control Work***	**15-16*th weeks***
9.	**Optical scheme of a laser polarimetric analyzer of biomicroparticles. Modern biotechnology, computer and nanotechnology.**	PRN3, PRN7, PRN 10, PRN13, PRN22, PRN23, PRN 24	***Abstract,Test***	**17-18*th weeks***

4. Training materials and resources

Basic literature:

1. . Богомолов, М. Ф. Лабораторна аналітична техніка. Конспект лекцій до вивчення кредитного модуля дисципліни «Методи та засоби діагностики-1. Лабораторна аналітична техніка» для студентів спеціальності 163 «Біомедична інженерія» та 152 «Метрологія та інформаційно-вимірювальна техніка» [Електронний ресурс] : навчальний посібник для студентів спеціальності 163 «Біомедична інженерія» та 152 «Метрологія та інформаційно-вимірювальна техніка» / Богомолов М. Ф., Шликов В. В. ; КПІ ім. Ігоря Сікорського. – Електронні текстові дані (1 файл: 3,38 Мбайт). – Київ : КПІ ім. Ігоря Сікорського, 2020. – 69 с.
2. Bogomolov M.F. Development and operation of physiotherapeutic medical devices: lecture notes for the study of the discipline " Development and operation of physiotherapeutic medical devices " [Electronic resource]: a textbook for bachelor's degree in specialty 163 - "Biomedical Engineering", specialization "Medical Engineering" / KPI. Igor Sikorsky; structure. M.F. Bogomolov, V.V. Shlykov, M.M. Sychyk – Kyiv: KPI Igor Sikorsky, 2023. – 60 p. Дата затвердження: 2023-06-02 Номер протоколу: 8 Примірник надано до бібліотеки у: - електронній формі: **ttps://ela.kpi.ua/handle/123456789/57376 .**

3. Лабораторна аналітична техніка: Лабораторний практикум [Електронний ресурс]: навч. посіб. для студ. спеціальності 163 «Біомедична інженерія» та 152 «Метрологія та інформаційно-вимірювальна техніка», спеціалізації «Клінічна інженерія» / М.Ф. Богомолов, С.І. Вовянко, В.В.Шликов– Київ: КПІ ім. Ігоря Сікорського,2018.-120с.; Url:http://ela.kpi.ua/handle/123456789/25316;2.

Additional literature (electronic resources):

1. Bisht P. B. An Introduction to Photonics and Laser Physics with Applications. Bristol: IOP Publishing, 2022. 350 p.
2. Peatross J., Ware M. Physics of Light and Optics. Provo: Brigham Young University, 2015. 400 p.
3. Hooker S., Webb C. Laser Physics. Oxford: Oxford University Press, 2010. 608 p.
4. Shulika O., Sukhoivanov I. Advanced Lasers: Laser Physics and Technology for Applied and Fundamental Science. Dordrecht: Springer, 2015. 234 p.

5. Renk K. F. Basics of Laser Physics: For Students of Science and Engineering. 2nd ed. Cham: Springer, 2017. 676 p.
6. Duarte F. J. Tunable Laser Applications. 3rd ed. Boca Raton: CRC Press, 2016. 480 p.
7. Mordon, S., & Svaasand, L. O. (2019). Laser-tissue interactions: Photophysical and photochemical effects. Journal of Biomedical Optics, 24(7), 1–15.
8. Huang, Z., & Chen, Y. (2020). Advances in laser-induced thermal therapy for cancer treatment. Frontiers in Oncology, 10, 1–12.
9. Zhang, L., & Xu, W. (2018). Numerical modeling of laser heating in biological tissues: A review. Journal of Heat Transfer, 140(5),
10. Karu, T. I. (2018). Photobiology of low-power laser effects. Health Physics, 114(5), 505–514.
11. Rohleder, N., & Nater, U. M. (2019). Determinants of salivary alpha-amylase in humans and methodological considerations. Psychoneuroendocrinology, 100, 111–123.
12. Tuchin, V. V. (2018). Tissue Optics: Light Scattering Methods and Instruments for Medical Diagnosis. 3rd ed. Bellingham: SPIE Press.
13. Flow Cytometry: An Overview Katherine M. McKinnon
14. – Режим доступу до ресурсу: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5939936/
15. Flow Cytometry Controls, Instrument Setup,and the Determination of PositivityHolden T. Maecker* and Joseph Trotter– Режим доступу до ресурсу: https://onlinelibrary.wiley.com/doi/epdf/10.1002/cyto.a.20333
16. Ultraviolet 320 nm Laser Excitation for Flow Cytometry William Telford1,* , Lynn Stickland2,3, Marco Koschorreck3 1Experimental Transplantation and Immunology Branch, National Cancer Institute, National Institutes of Health, Bethesda, MD 20892 2LASOS North America 3LASOS Lasertechnik GmbH Franz-Loewen-Straße 2, 07745 Jena, Germany– Режим доступу до ресурсу: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7974379/pdf/nihms-1670334.pdf
17. Solid State Yellow and Orange Lasers for Flow Cytometry Veena Kapoor1, Vladimir Karpov2, Claudette Linton2, Fedor V. Subach3, Vladislav V. Verkhusha3, William G. Telford1,* 1Experimental Transplantation and Immunology Branch, NCI-NIH, Bethesda, Maryland 2MPB Communications, Montreal, Quebec, Canada 3Department of Anatomy and Structural Biology, Albert Einstein College of Medicine, Bronx, New York– Режим доступу до ресурсу: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7410328/pdf/nihms-1585498.pdf
18. Green fiber lasers: An alternative to traditional DPSS green lasers for flow cytometry William G. Telford1,* , Sergey A. Babin2,§, Serge V. Khorev2, and Stephen H. Rowe2 1Experimental Transplantation and Immunology Branch, NCI-NIH, Bethesda, MD, USA 2Zecotek Laser Systems Pte. Ltd., Zecotek Photonics Inc., Singapore– Режим доступу до ресурсу: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2798129/pdf/nihms162412.pdf
19. Supercontinuum white light lasers for flow cytometry William G. Telford1,* , Fedor V. Subach2, and Vladislav V. Verkhusha2 1 Experimental Transplantation and Immunology Branch, NCI-NIH, Bethesda, MD, USA 2 Department of Anatomy and Structural Biology, Albert Einstein College of Medicine, Bronx, NY, USA– Режим доступу до ресурсу: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2674127/pdf/nihms90035.pdf
20. Near infrared lasers in flow cytometry William Telford, Ph.D. Experimental Transplantation and Immunology Branch, National Cancer Institute, National Institutes of Health, Bethesda, MD USA– Режим доступу до ресурсу: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8363084/pdf/nihms-679232.pdf
21. Telford WG, Huber C. Novel solid-state lasers in flow cytometry. Biophoton Int 2006;13:50–53.
22. Nakamura S, Fasol G. The Blue Laser Diode GaN Based Light Emitters and Lasers. Berlin: Springer; 1997– Режим доступу до ресурсу: https://books.google.com.ua/books?hl=uk&lr=&id=zZXsCAAAQBAJ&oi=fnd&pg=PA4&ots=Y-K5reYyzu&sig=pGZ4FDQZY3xax2DqrcZ503PVFB4&redir_esc=y#v=onepage&q&f=false

23. Shapiro HM, Perlmutter NG. Violet laser diodes as light sources for cytometry. Cytometry 2001;44:133–136.– Режим доступу до ресурсу: https://pubmed.ncbi.nlm.nih.gov/11378864/
24. Telford WG. Analysis of UV-excited fluorochromes by flow cytometry using a near-UV laser diode. Cytometry Part A 2004;61A:9–17.– Режим доступу до ресурсу: https://pubmed.ncbi.nlm.nih.gov/15351984/
25. Telford WG, Kapoor V, Jackson J, Burgess W, Buller G, Hawley T, Hawley R. Violet laser diodes in flow cytometry: An update. Cytometry Part A 2006;69A:1153–1160.– Режим доступу до ресурсу: https://pubmed.ncbi.nlm.nih.gov/17051581/
26. Chattopadhyay PK, Gaylord B, Palmer A, Jiang N, Raven MA, Lewis G, Reuter MA, Nur-ur Rahman AK, Price DA, Betts MR, et al. Brilliant violet fluorophores: a new class of ultrabright fluorescent compounds for immunofluorescence experiments. Cytometry Part A 2012;81A:456–466.– Режим доступу до ресурсу: https://pubmed.ncbi.nlm.nih.gov/22489009/
27. Ota S., Sato I., Horisaki R. Implementing machine learning methods for imaging flow cytometry. Microscopy. 2020;69:61–68. doi: 10.1093/jmicro/dfaa005.– Режим доступу до ресурсу: https://academic.oup.com/jmicro/article/69/2/61/5770847#google_vignette
28. Imaging Flow Cytometry: Development, Present Applications, and Future Challenges Savvas Dimitriadis 1,†, Lefkothea Dova 1,†, Ioannis Kotsianidis 2, Eleftheria Hatzimichael 3, Eleni Kapsali 3, Georgios S Markopoulos 1,4,– Режим доступу до ресурсу: https://pmc.ncbi.nlm.nih.gov/articles/PMC11054958/
29. Shapiro HM. Trends and developments in flow cytometry instrumentation. In Clinical Flow Cytometry, Ann NY Acad Sci 1993, 677: 155–166. – Режим доступу до ресурсу: https://nyaspubs.onlinelibrary.wiley.com/doi/10.1111/j.1749-6632.1993.tb38774.x
30. Bendall SC, Nolan GP, Roederer M, Chattopadhyay PK. A deep profiler's guide to cytometry. Trends Immunol 2012, 33:323–332. – Режим доступу до ресурсу: https://pubmed.ncbi.nlm.nih.gov/22476049/
31. Shapiro HM, Telford WG. Lasers for flow cytometry. In Current Protocols in Cytometry, Robinson JP, Darzynkiewicz Z, Dobrucki J, Hoffman RA, Nolan JP, Orfao A, Rabinovitch PS, eds., John Wiley and Sons, New York, NY, 2009, page 1.9.
32. Telford WG. Lasers in flow cytometry. In Recent Advances in Cytometry, Methods in Cell Biology Volume 102, Darzykiewicz Z et al. eds., Academic Press, New York, NY, 2011, pp. 375–410. – Режим доступу до ресурсу: https://pubmed.ncbi.nlm.nih.gov/21704847/
33. .Gray JW, Cram LS. Flow karyotyping and chromosome sorting. In Flow Cytometry and Sorting, 2nd Edition, Wiley-Liss, 1990, pp. 503–529.
34. Hoffman RA, Reinhardt BN, Stevens FE. Two-color immunofluorescence using a red helium neon laser. Cytometry Supp 1987, 1: 103.
35. Loken MR, Keij JF, Kelley KA. Comparison of helium-neon and dye lasers for the excitation of allophycocyanin. Cytometry 1987, 8: 96. – Режим доступу до ресурсу: https://pubmed.ncbi.nlm.nih.gov/3542436/
36. Shapiro HM. The little laser that could: applications of low power lasers in clinical flow cytometry. Ann. N.Y. Acad. Sci 1986; 468, 18.– Режим доступу до ресурсу: https://pubmed.ncbi.nlm.nih.gov/2942089/
37. Doornbos RMP, De Grooth BG, Kraan YM, Van Der Poel CJ, Greve J. Visible diode lasers can be used for flow cytometric immunofluorescence and DNA analysis. Cytometry 1994, 15: 267–271. – Режим доступу до ресурсу: https://pubmed.ncbi.nlm.nih.gov/8187585/
38. Nakamura S, Fasol G. The blue laser diode. GaN based light emitters and lasers. Berlin: Springer, 1997.
39. Shapiro HM, Perlmutter NG. Violet laser diodes as light sources for cytometry. Cytometry 2001, 44: 133–136.

40. Telford WG, Hawley TS, Hawley RG. Analysis of violet-excited fluorochromes by flow cytometry using a violet laser diode. Cytometry 2003, 54A: 48–55. – Режим доступу до ресурсу: https://pubmed.ncbi.nlm.nih.gov/12820120/
41. Telford WG, Kapoor V, Jackson J, Burgess W, Buller G, Hawley T, Hawley R. Violet laser diodes in flow cytometry: an update. Cytometry 2006, 69:1153–60. Режим доступу до ресурсу: https://pubmed.ncbi.nlm.nih.gov/17051581/
42. Chattopadhyay PK, Perfetto SP, Yu J, Roederer M. The use of quantum dot nanocrystals in multicolor flow cytometry. Wiley Interdiscip Rev Nanomed Nanobiotechnol 2010, 2:334–348. – Режим доступу до ресурсу: https://pubmed.ncbi.nlm.nih.gov/20101649/
43. Chattopadhyay PK, Gaylord B, Palmer A, Jiang N, Raven MA, Lewis G, Reuter MA, Nurur Rahman AK, Price DA, Betts MR, Roederer M. Brilliant violet fluorophores: a new class of ultrabright fluorescent compounds for immunofluorescence experiments. Cytometry A 2012, 81:456–466. – Режим доступу до ресурсу: https://pubmed.ncbi.nlm.nih.gov/22489009/
44. Telford WG, Murga M, Hawley T, Hawley RG, Packard BZ, Komoriya A, Haas R, Hubert C. DPSS yellow-green 561 nm lasers for improved fluorochrome detection by flow cytometry. Cytometry 2005, 68A, 36–44. – Режим доступу до ресурсу: https://pubmed.ncbi.nlm.nih.gov/16163703/

45. **Інформаційні ресурси**
1. http://info-library.com.ua/books-text-4072.html.
2. http://www.twirpx.com.
3. **Електронний кампус. Викладач М.Ф.Богомолов.**
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.
9. http://ela.kpi.ua/handle/123456789/16554.

Educational content

5. **Methods of mastering the discipline "*Modern optoelectronic diagnostic devices*" (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. Biophotonics. Structure. Features of the interaction of laser radiation with biomaterial.						
Topic 1.1. Features of laser methods of biomedical research.	10	4				6
Topic 1.2. Features of photochemical reactions and chemiluminescence. Position of the discipline in the training system.	9	2	2			5
Topic 1.3. Photodynamic effect of	10	2	2			6

Names of sections and topics	Number of hours					
	Total	including				
		Lectures	Practical (seminar)	Computer workshops	Laboratory	Independent student work
endogenous sensitizer. Interaction of laser radiation with biological objects.						
Topic 1.4. Laser and optical methods in laboratory diagnostics.	13	6	4			3
Total by Section 1	**42**	**14**	**8**			**20**
Section 2. Theoretical foundations of optoelectronic radiation sources, fiber-optic paths, devices and systems.						
Topic 2.1 Main characteristics of laser and optoelectronic radiation sources. Schemes for measuring the main characteristics of laser and optoelectronic radiation sources.	12	2	4			6
Topic 2.2. Basic optical schemes for measuring the characteristics of fiber-optic transmission paths of biomedical teleinformation.	11	1	4			6
Topic 2.3. Optoelectronic circuit of a medical interferometric laser analyzer of bioobjects.	4.5	1	2			1.5
Topic 2.4. Modern optoelectronic diagnostic medical measuring devices, interferometers, spectrophotometers and fiber optic sensors.	18	2	2			14
Topic 2.5. Optoelectronic circuit of a medical interferometric analyzer of bioobjects.	8.5	2	2			4.5
Topic 2.6. Absorption laser methods for studying biological objects.	6	2	2			2
Topic 2.7 Nephelometric optoelectronic analyzers of bioobjects. Multiparametric laser and optoelectronic cytometry.	13	2	2			9
Total by Section 2	**73**	**12**	**18**			**43**
Modular control work	5		2			3
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	**Biophotonics. Structure. Features of the interaction of radiation of optoelectronic devices with biomaterial. Features of optoelectronic methods of biomedical research. The main advantages of using optoelectronic methods and devices for diagnosing human diseases. The main purpose of using diagnostic optoelectronic device systems and biomedical equipment. Technical means, parameters and characteristics of automatic design systems for biomedical equipment. Basic principles of creating automatic design systems for biomedical equipment.** **Literature [1] – P. 425, [2] – P. 5-38.** **List of teaching aids: Lecture notes; multimedia projection equipment; Power Point presentation.** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources**.**	4
2	**Features of photochemical reactions and chemiluminescence. Position of the discipline in the training system. Photodynamic effect of endogenous sensitizer. Principle of photodynamic influence and stimulation of formed elements of human blood. Principles of completeness, development, compatibility, standardization and inventory, inclusion and accumulation of experience. Mathematical formulation of the problem of designing biomedical equipment, selection of numerical methods of solution, development of a design algorithm, mathematical models and methods.** **Literature [2] – C. 40-54.** **List of teaching aids: Lecture notes; multimedia projection equipment; Power Point presentation.** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources.	3
3	**Main characteristics of optoelectronic radiation sources. Measurement schemes of the main characteristics of laser radiation sources. Structure and principle of operation of helium-neon, argon and molecular lasers. Electrical and optical characteristics of semiconductor laser diodes. Physical foundations of the formation of the inversion state of the active substance for a gas medium and a semiconductor crystal. Structural diagrams of modern atomic, ionic and molecular lasers. Energy diagrams of an active gas medium and semiconductors. Energy diagram of a degenerate semiconductor. Areas of application, optical diagrams of quantum devices in modern optoelectronic measuring systems. Mathematical equations describing the inversion state of the active substance, model and calculation of optical diagrams of modern optoelectronic devices.** **Literature [1] – C.438 – 442.** **List of teaching aids: Lecture notes; multimedia projection equipment; Power Point presentation.** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources.	3
4	**Basic optical schemes for measuring the characteristics of fiber-optic transmission paths of biomedical teleinformation. Basic characteristics of fiber optic cables. Methods for measuring the numerical aperture of fiber optic cables. Dispersion of fiber optic cables, basic types and measurement schemes. Mechanisms of radiation attenuation in fiber optic cables, methods and modern devices for measuring losses in optical paths.. Collapsible and non-collapsible fiber optic connectors. Methods for monitoring and measuring radiation propagation parameters in optical cables when designing modern telecommunication systems.** **Literature [8, c.97-140;11, c.96-126; 21, c.76-105].**	3

	List of teaching aids: Lecture notes; multimedia projection equipment; Power Point presentation. **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources **.**	
5	**Optoelectronic circuit of a medical interferometric laser analyzer of bioobjects. Calculation of technical characteristics of the radiation source of fiber-optic medical systems. Minimum permissible radiation power at the input of the photodetector. Transmission speed of useful information. Losses of radiation power due to packaging of fiber optic cables. Calculation of the main losses of radiation power in fiber optic paths.** **Literature [6, c.55-78; 11, c.66-98; 20, c.71-129].** **List of teaching aids: Lecture notes; multimedia projection equipment; Power Point presentation.** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources.	**3**
6	**Modern optoelectronic diagnostic medical measuring devices, interferometers, spectrophotometers and fiber-optic sensors. Features of object-oriented methods of designing biomedical equipment. Fiber-optic converters with phase modulation. Basic modern optical schemes of Mach-Zehnder and Michelson interferometers. Laser fiber-optic Doppler velocity meters of differential and heterodyne types. Fiber-optic gyroscopes. Fiber-optic converters for measuring magnetic and electric fields, temperature, vibration loads, microdisplacements of objects, microcurrents of biological signals.** **Literature [1, c. 44-96; 3, c.55-97; 16, c.112-139; 17, c.105-123].** **List of teaching aids: Lecture notes; multimedia projection equipment; Power Point presentation.** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources**.**	**3**
7	**Optoelectronic circuit of a medical interferometric analyzer of bioobjects Features of the constructive hierarchy of biomedical equipment, designs of the second level of complexity, block frames. Planar optical waveguides. Methods of matching optical integrated circuits with fiber optic cables and radiation sources. Active devices of integrated optics. Electro-optic modulators and deflectors. Semiconductor photodetectors. Optoelectronic integrated circuits. Integrated-optical devices for information transmission and processing systems. Integrated-optical generators, multipliers, switches, mixers, signal correlators. Influence of external destabilizing mechanical and climatic factors. Characteristics of vibration-shock resistance and temperature stabilization systems of biomedical equipment.** **Literature [5, c.97-114; 8, c.106-123; 11, c.96-117].** **List of teaching aids: Lecture notes; multimedia projection equipment; Power Point presentation.** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources**.**	**3**
8	**Absorption laser methods of studying biological objects.** **Fiber-optic indicatrix meters of scattered radiation during the interaction of a laser beam with biological objects. Basic optical schemes of fiber-optic meters using modern fiber-optic single-mode paths with preservation of polarization of laser radiation.** **Literature [7,c.65-98; 11, c.76-93; 18, c.117-134].** **List of teaching aids: Lecture notes; multimedia projection equipment; Power Point presentation.** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources**.**	**1**
9	**Nephelometric optoelectronic analyzers of bioobjects. Multiparametric laser and optoelectronic cytometry. Fiber-optic converters for measuring Raman laser**	**3**

	radiation. Main characteristics of fiber-optic modules and systems for modern meters in medical diagnostic systems. Features of designing structures of biomedical devices and preparation of the necessary technological documentation for implementation in production using 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].** **List of teaching aids: Lecture notes; multimedia projection equipment; Power Point presentation.** **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].**	
Total hours		**26**

Practical The main tasks of the series of practical classes: consolidation in practice of the main provisions of the discipline ***" Modern optoelectronic diagnostic 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	**Interaction of laser radiation with medium and large blood particles.** **Literature** [2] – P. 40-54. **List of didactic aids:** projection multimedia equipment, tables of physical constants, computing equipment. **Tasks for the SRS:** Study the lecture material, prepare for practical classes on these sections based on the lecture notes.	**4**
2	**Features of laser radiation scattering from blood cells.** **Literature** [1] – P. 58-81. **List of didactic aids:** projection multimedia equipment, tables of physical constants, computing equipment. **Tasks for the SRS:** Study the lecture material, prepare for practical classes on these sections based on the lecture notes.	**4**
3	**Features of laser radiation scattering from blood cells.** **Literature** [1] – P. 438-442. **List of didactic aids:** projection multimedia equipment, tables of physical constants, computing equipment. **Tasks for the SRS:** Study the lecture material, prepare for practical classes on these sections based on the lecture notes.	**4**
4	**Computer methods for processing the speckle structure of laser radiation scattered by microbioobjects.** **Literature** [1] – P.426 – 433, [2] – P.230- 252. **Tasks for the SRS:** Study the lecture material, prepare for practical classes on these sections based on the lecture notes.	**2**
5	**Determination of parameters of the blood fluid medium using the indicatrix of laser radiation scattering.Literature** [1] – P.426 – 433. **Tasks for the SRS:** Study the lecture material, prepare for practical classes on these	**4**

	sections based on the lecture notes.	
6	**Energy and phase characteristics of laser radiation scattered by spherical microbioparticles.** **Literature** [1] – P. 387-394. **Tasks for the SRS:** Study the lecture material, prepare for practical classes on these sections based on the lecture notes.	**4**
7	**Spatial and temporal coherence of laser radiation sources. Experimental research schemes.** **Literature** [1] – P. 433-438, [2] – 3. 284-300, 441-484. **Tasks for the SRS:** Study the lecture material, prepare for practical classes on these sections based on the lecture notes.	**2**
8	**Features of interference and diffraction of laser radiation.** **Modern methods and devices for processing biomedical diagnostic information.** **Literature** [2] – P.284-300, 441-461. **Tasks for the SRS:** Study the lecture material, prepare for practical classes on these sections based on the lecture notes.	**4**
Total hours		**28**

Laboratory classes – not scheduled

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 ***" Modern optoelectronic diagnostic 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.

Approximate topics (name of individual task):

1. Classification of modern laser and optoelectronic devices.

2. Methods of pumping lasers, creating inversion, 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 analyzing optical characteristics of various objects.

10. Modeling of scattering indicatrix for biological objects.

11. Computer modeling of processes of interaction of laser radiation with blood elements.

12. Determination of microparticle parameters using computer processing of scattering indicatrix.

13. Computer methods for analyzing laser radiation scattering processes.

14. Influence of microparticle parameters on the laser scattering indicatrix.

15. Features of laser radiation scattering from human blood.

16. Computer methods for modeling laser radiation scattering from biological objects.

17. Computer methods for 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 2024 and 2025", etc.**

Distance learning platform: For more effective communication in order to understand the structure of the discipline ***" Modern optoelectronic diagnostic 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	**Topic 1.1 System analysis of the design of modern optoelectronic diagnostic**	**10**

№ s/n	Names of topics and questions submitted for self-study and references to educational literature	Hours ISW
	devices **List of questions submitted for independent study: Features of the system of automatic design of biomedical equipment. Complex of design tools. Necessary divisions of design organizations.** **Literature [3,P.34-78;5,P.26-52;7,P.47-59].** **Lectures – No. 2** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources**.**	
2	**Topic 2.1 Technical support of CAD of modern optoelectronic diagnostic devices. Stages of functioning and design of modern optoelectronic diagnostic devices.** **List of questions submitted for independent study: Principles of completeness, development, compatibility, standardization and inventory, inclusion and accumulation of experience. Mathematical formulation of the problem of designing biomedical equipment, selection of numerical methods of solution, development of a design algorithm, mathematical models and methods.** **Literature: [2, P.19-25; 3, P. 41-53; 4, P. 10-17.].** **Lectures – No. 3** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources**.**	**10**
3	**Topic 2.2 Mathematical support of CAD for designing BM REA for optoelectronic laboratory diagnostics.** **List of questions submitted for independent study: Features of using software in the design of printed assemblies and components of biomedical equipment. Application of modern software products for automated design, production of technical and technological documentation when implementing the proposed design solutions in production.** **Literature: [4, P.34-58;7, P.26-47;9, P.38-51.].** **Lectures – No. 5,6** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources.	**12**
4	**Topic 2.3 CAD software. Complex of automated design tools for modern optoelectronic diagnostic devices.** **List of questions submitted for independent study: Features of the generalized algorithm for automated design of biomedical equipment, interaction of software and methodological complexes and software and technical complexes. The set of interactions of all structural elements of CAD of biomedical equipment.** **Literature: [4, P. 28-43; 6, P.37-51; 9, P.48-62.].** **Lectures – No. 8** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources **.**	**9**
5	**Topic 2.4 Information support of CAD for the design of modern optoelectronic diagnostic devices.** **List of questions submitted for independent study: The range of properties, parameters and characteristics of information support of CAD 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 the design of biomedical equipment.** **Literature: [2, P.25-38; 7, P.46-53; 9, P.67-81.].** **Lectures – No. 10.** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical	**8**

№ s/n	Names of topics and questions submitted for self-study and references to educational literature	Hours ISW
	lesson on these sections, to study literary sources**.**	
6	**Topic 2.5 Scientific and methodological principles of designing modern optoelectronic diagnostic devices .** **List of questions submitted for independent study: Mathematical models of processes that are carried out in biomedical equipment. Probable characteristics of a set of random variables in the process of designing biomedical equipment. Basic structural and design modules of the first level (SCM1).** **Literature: [2, P.15-28;8, P.25-47;10, P.44-57.].** **Lectures – No. 11.** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources**.**	**7**
7	**Topic 3.1. Automated design systems for modern optoelectronic diagnostic devices .** **List of questions submitted for independent study: . Features of automatic tracing of printed conductors of electronic modules of biomedical equipment in the Dip Trace system. Production of technological documents for the design of biomedical equipment in the Solid Works Simulation system. Features of the design of structures of biomedical devices and the preparation of the necessary technological documentation for implementation in production using the Solid Works Simulation design system.** **Literature: [10,P.73-94;11,P.63-89;12,P.97-105.].** **Lectures – No. 14** **Tasks on ISW:** To study the material of the lecture, to prepare for a practical lesson on these sections, to study literary sources**.**	**10**
Total hours		**66**

Policy and control

7. Policy of academic discipline " *Modern optoelectronic diagnostic devices*" (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 **" Modern optoelectronic diagnostic 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 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.

[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.*

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. *Positive result of the first attestation and the second attestation.*
3. *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 **Abstract**, 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, as well as for preparation for the test: 1. Laser analyzers of human blood parameters. Schemes, characteristics.

2. Laser flow cytometry devices. Schemes, characteristics.
3. Application of lasers for the diagnosis of human blood diseases.
4. Laser therapeutic devices. Schemes, characteristics.
5. Application of UV lasers in medicine. Schemes, characteristics.
6. Application of IR lasers in medicine. Schemes, characteristics.
7. Effect of UV and IR radiation on biological objects.
8. Laser nephelometers. Principles of action, optical schemes, designs.
9. Application of lasers for irradiation of human blood. Schemes, characteristics.
10. Modern laser devices for measuring sugar content in human blood. Schemes, characteristics.
11. Modern laser scalpels on CO2 and solid-state lasers.
12. Fiber-optic medical endoscopes. Designs, characteristics.
13. Application of lasers in ophthalmology. Schemes, designs.
14. Application of lasers in oncology. Schemes, designs.
15. Application of lasers for therapy. Schemes, designs.
16. Application of lasers for diagnosis of diseases. Schemes, designs.
17. Application of lasers in surgery. Schemes, designs.
18. Application of lasers for treatment of human skin diseases, cosmetology.
19. Application of He-Ne lasers for treatment of cardiovascular diseases. Schemes, characteristics.
20. Application of laser spectrophotometers for diagnosis of human blood 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.**

Appendices to the syllabus of the discipline " Modern optoelectronic diagnostic devices"

Appendix 1. Program learning outcomes (extended form)

As a result of studying the discipline ***" Modern optoelectronic diagnostic 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 optoelectronic diagnostic 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	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

	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).		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 systems, as well as medical products, in the process of professional activity (Reinforcement).	ZК 2 Knowledge and understanding of the subject area and understanding of professional activity (Reinforcement).	FК 2 Ability to provide engineering and technical expertise in the planning, development, evaluation, and specification of medical equipment (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).	ZК 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).	FК 12 Ability to ensure and monitor compliance with safety and biomedical ethics when working with medical equipment (Reinforcement).

Appendix 2. Methodological recommendations for writing and formatting an abstract.

One of the main types of semester control during the mastering of the academic discipline "***Modern optoelectronic diagnostic devices***" is the execution of an essay. The essay is performed in accordance with the requirements, within the period specified by the teacher.

The main objectives of the individual essay assignment are a task that involves solving a specific practical educational task based on the materials of the theoretical volume of the discipline "***Modern optoelectronic diagnostic devices***" using known, as well as independently studied theoretical material on the design and construction of modern optoelectronic diagnostic analytical devices for a wide range of medical purposes. A significant part of such work consists of graphic material, which is performed in accordance with current regulatory requirements and with the mandatory use of computer graphics, if this is determined by the assignment, and using modern software systems for the design of optoelectronic diagnostic analytical devices for laboratory purposes. Control work, as well as calculation work, may include certain illustrative material.

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

1. Laser diagnostic complex for cardiological research. Schemes, features of operation.
2. The use of computers for the diagnosis of heart diseases. Modeling the human heart.
3. Methods of active laser thermography using hyperbaric oxygenation.
4. Modern electrocardiography devices. Schemes, characteristics.
5. Acoustic and holographic thermography. Schemes, characteristics.
6. Modern methods of thermographic diagnostics. Schemes, characteristics.
7. Modern diagnostic complexes for laboratory and clinical research. Principle of operation. Schemes, characteristics.
8. Modern laser autoanalyzers. Features of operation, schemes, characteristics.
9. Modern devices for laser UV spectroscopy. Features of operation, schemes, characteristics.
10. Modern laser fluorometers. Features of operation, schemes, characteristics.
11. Modern optical laser cytometers. Features of operation, schemes, characteristics.
12. Laser systems for the study of human blood parameters. Features of operation, schemes, characteristics.
13. Laser and optoelectronic complexes for studying the optical characteristics of biological objects. Features of operation, schemes, characteristics.
14. Diagnostic laser and optoelectronic equipment for recording human biopotentials. Features of operation, schemes, characteristics.
15. Features of operation of devices for laser and electromyography, electrogastrography. Basic schemes, characteristics.
16. Laser systems for studying human blood parameters. Features of operation, schemes, characteristics.
17. Laser complexes for studying the optical characteristics of biological objects. Features of operation, schemes, characteristics.
18. Diagnostic equipment for recording human biopotentials. Features of operation, diagrams, characteristics.
19. Features of the operation of devices for electromyography and electrogastrography. Basic schemes, characteristics.

The title page of the **abstract** should have the following content: name of the university; name of the faculty; name of the department; name of the specialty, name of the educational and professional program, registration number, name of the academic discipline; topic of the calculation and graphic work; surname and name of the student, course, academic group number, year.

The title page is followed by a detailed plan (content of the abstract, which should include an introduction, 3 sections of the main content (analysis of literary sources, description of the functional scheme, calculation of the functional unit or development of software), their subdivisions (if necessary), conclusion, list of sources used. The page numbers of the beginning of each question are indicated on the right in the table of contents. Each section begins with a new page.

The total volume of the **abstract**, depending on the chosen topic, can vary from **30** to **40** pages of the main text (upon agreement with the teacher). The volume of the calculation and graphic work is determined by the student's ability to briefly and at the same time exhaustively reveal the topic: the relevance of the topic under consideration, modern trends and problems, analyze the best foreign and Ukrainian technologies, draw conclusions and justify their own proposals and recommendations.

An abstract is provided in two languages - **Ukrainian and English**, indicating keywords.

Mandatory requirement: a clear reference to the sources of information. All numbers, facts, opinions of scientists, quotes, formulas must have references in the form of **[2, p.54]** (the first digit means the number of the source in the list of literature given at the end of the creative work, and the second digit is the page number in this source). It is advisable to use tables, diagrams, graphs, charts, etc. The list of sources used (at least **10** sources) is drawn up in accordance with the current rules. If the information is taken from the **Internet**, it is necessary, as for ordinary literature, to indicate the author, the title of the article, and then give the address of the site on the Internet.

The **abstract** is evaluated according to the following criteria: logicality of the plan; completeness and depth of disclosure of the topic; availability of illustrations (tables, figures, diagrams, screenshots of web pages, etc.); number of sources used and clarity of references to them; reflection of practical materials and calculation results; design; substantiation of the student's own opinion on this issue in the form of a conclusion.

Deadline for submitting an abstract for verification: **10** days before the start of the test session.
The abstract is not checked for plagiarism, but must meet the requirements of academic dishonesty. If academic dishonesty is detected, the work is canceled and not checked.

.

Work program of the discipline " Modern optoelectronic diagnostic 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.