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

Department
biomedical engineering

Biomedical information display systems

Working program of basic discipline (Syllabus)

Details of the discipline	
Level of higher education	***Second (master's)***
Branch of knowledge	*16 Chemical and Bioengineering*
Specialty	*163 Biomedical Engineering*
Educational program	*Medical Engineering*
Discipline status	*Mandatory discipline*
Form of study	*full-time / day / mixed / remote*
Year of preparation, semester	*1 course, autumn semester*
The scope of discipline	*5 ECTS credit (150 hours)*
Semester control / control measures	*Modular Test Work, Exam, Term paper*
Lessons schedule	*Lectures (28 hours) - every week, practical classes (46 hours) - 3 classes / 2 weeks (According to the schedule on the website http://rozklad.kpi.ua/)*
Language of instruction	*English*
Information about the course leader / teachers	***Lecturer:*** *PhD. physical and mathematical Sciences, Associate Professor, Andriy Vyacheslavovich Solomin, a.solomin@kpi.ua ; andr-sol@i.ua ; Phone 0509271063* ***Practical:*** *PhD. physical and mathematical Sciences, Associate Professor, Andriy Vyacheslavovich Solomin, a.solomin@kpi.ua ; andr-sol@i.ua ; Phone 0509271063*
Teacher profile	*https://intellect.kpi.ua/profile/sav231* *http://bmi.fbmi.kpi.ua/department/staff-department/*
Course placement	*Sikorsky (Moodle) https://do.ipo.kpi.ua/course/view.php?id=2283* *Individual video conference room Zoom 650 976 8233*

Curriculum of the discipline

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

The discipline "Biomedical Information Display Systems" belongs to the cycle of normative (Mandatory) disciplines of the cycle of general training of masters. It is designed for students who have a bachelor's degree in engineering.

The basis of any diagnostic equipment is the transformation of information of different physical nature into a form that can be perceived and interpreted by a biomedical specialist-diagnostician. By the physical nature of research, modern diagnostic equipment is very different, but obtaining convenient and reliable diagnostic information in modern conditions is impossible without its processing by special information systems with elements of artificial intelligence. The development and operation of such systems is currently very relevant in all biomedical fields. This requires the training of specialists who are able to apply the acquired knowledge in obtaining and processing diagnostic information in research, design and service-operational activities in all areas of biomedicine.

The purpose of the discipline

The main purpose of the discipline "Biomedical Information Display Systems" is to form students' ability to use methods, principles, technologies and tools for obtaining, processing and visualization of biomedical information of various physical nature, which has diagnostic and research value.

Training in the discipline "Biomedical Information Display Systems" is based on a student-centered approach and a strategy of interaction between teacher and student in order for students to master the material and develop their practical skills.
As the discipline "Biomedical Information Display System" is considered difficult to master and is developing very rapidly, as well as having in mind the requirements of the industry standard and the specifics of medical and biological applications and significantly heterogeneous nature of general training, its teaching should be guided by the following principles.
The methodical model of teaching the discipline is based on the use of active teaching methods. The organization is based on the following principles:
- the choice of teaching methods depending on the various factors influencing the organization of the educational process, the contingent of students;
- heuristic methods (methods of creating ideas, methods of solving creative problems, methods of activating creative thinking);
- active participation of students in the learning process;
- giving examples of the use of theoretical material to real practical situations;
- emphasizing the features of the subject in relation to the medical and biological aspects of use, interest in new developments and technologies;
- flexible and differentiated approach to each student, taking into account the degree of general training;
- forecasting the directions of technology development in the future.
During training and for interaction with students modern information-communication and network technologies are used, the corresponding online course in the Sikorsky (Moodle) system is developed and constantly improved.

Program competencies

General competencies

GC 1	*Ability to abstract thinking, analysis and synthesis.*
GC 2	*Ability to search, process and analyze information from various sources.*
GC 3	*Ability to identify, formulate and solve problems.*
GC 4	*Ability to work in a team.*
GC 5	*Ability to work in an international context.*

Special (professional) competencies:

PC 1	*Ability to solve complex problems of biomedical engineering using the methods of mathematics, natural and engineering sciences.*
PC 2	*Ability to develop a working hypothesis, plan and set experiments to test the hypothesis and achieve the engineering goal using appropriate technologies, technical means and tools.*
PC 3	*Ability to analyze complex medical engineering and bioengineering problems and formalize them to find quantitative solutions using modern mathematical methods and information technology.*
PC 5	*Ability to develop terms of reference for creation, as well as to model, evaluate, design and construct complex bioengineering and medical engineering systems and technologies.*
PC 6	*Ability to study biological and technical aspects of functioning and interaction of artificial biological and biotechnical systems.*
PC 7	*Ability to work in a multidisciplinary team.*
PC 11	*Ability to develop, plan and apply mathematical methods in the analysis, modeling of the functioning of living organisms, systems and processes in biology and medicine.*
FC 12	*Ability to perform research and observations on the interaction of biological, natural and artificial systems (prostheses, artificial organs, etc.), to plan biotechnical tests of artificial prostheses and systems.*

Program learning outcomes:

PLO 1	*Understanding of fundamental-applied, medical-physical and bioengineering bases of technologies and equipment for research of physiological and pathological processes of the person .*
PLO 2	*Understanding the principles of action of modern diagnostic equipment and display systems of biomedical information, the basis of appropriate software .*
PLO 3	*Possession of modern methods of scientific research software, construction of adequate theoretical models and methods of their substantiation.*
PLO 4	*Application of calculation methods and selection of classical and new designs of biomaterials, elements of devices and systems of medical appointment .*
PLO 5	*Application of methods and tools for designing computer networks .*
PLO 6	*Possession of methods of designing digital microprocessor and biotechnical systems for medical purposes*
PLO 7	*Possession methods research, design and construction of objects of biomedical engineering, analysis and processing of experimental data .*
PLO 8	*Knowledge of general requirements for the conditions of engineering, technological and scientific projects .*
PLO 9	*Knowledge of the principles of development and modern problems of creating biocompatible materials in medical practice.*
PLO 13	*Knowledge of a foreign language to an extent sufficient for general and professional communication*
PLO 15	*Understanding of specialized conceptual principles acquired in the process of learning and/or professional activity at the level of the latest achievements, which are the basis for original thinking and innovation, in particular in the context of research work.*
PLO 22	*Presentation of research and development results in the state and foreign languages in the form of applications for inventions, scientific publications, reports at scientific and technical events.*
PLO 24	*Mastery of adaptation skills and action in situations related to work in the specialty, the ability to generate new ideas in the field of biomedical engineering.*
PLO 25	*Implementation of achievements of domestic and foreign science and technology, use of creative initiative, rationalization, invention and best practices that ensure the effective operation of the medical enterprise.*

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

The discipline "Biomedical Information Display Systems" is interdisciplinary. It integrates according to its subject knowledge from other disciplines (bachelor's degree programs): "Physics", "Fundamentals of of computer science", "Engineering and computer graphics", "Biophysics", "Radiation safety and dosimetry", "Biomedical Devices, apparatus and complexes","Examination and engineering support of medical equipment","Devices for control of person's physiological parameters", etc. According to the structural and logical scheme of the master's program, the discipline is closely related to other disciplines of general and professional training: "Medical Physics", "Diagnostic and therapeutic methods in arrhythmology and electrophysiology".

The acquired practical skills and acquired theoretical knowledge during the study of the discipline "Biomedical Information Display Systems" can be used in the future during the acquisition of disciplines:

- from selective disciplines (educational-professional program "Medical Engineering"): "Physiotherapeutic medical devices", "Electronic sensors and biochips", " Biophotonics and nanoelectronics", "Medical devices and technologies".

The acquired practical skills and acquired theoretical knowledge during the study of the discipline "Biomedical Information Display Systems" can be used later in undergraduate practice, for the preparation of a master's thesis and in further practical work in the specialty.

Necessary skills

1. Knowledge and practical skills in solving problems in physics.
2. Possession of knowledge and methodology in biophysics
3. Knowledge of the basics of clinical engineering and radiology.
4. Possession of the methodology of registration and processing of biosignals and medical images.

3. The content of the discipline

The main sections and topics that will be considered in the process of studying the course:

Section 1. Introduction to the discipline. Discrete and continuous signals and images.

Topic 1.1. The content of the discipline. Principles of receiving and processing of continuous and discrete signals.
Topic 1.2. Kotelnikov's theorem.
Topic 1.3. Core, impulse response of a linear system.

Section 2. Digital signal and image processing.

Topic 2.1. Discrete Fourier transform. Spectral analysis.
Topic 2.2. Filter, filter core.
Topic 2.3 Convolution. Correlation.
Topic 2.4 Examples of applications in biomedical engineering.

Section 3. Data analysis tools in biomedicine. Evidence-based medicine .

Topic 3.1. Elements of measurement theory.
Topic 3.2. Typical data analysis problems in a biomedical experiment. Data processing methods.
Topic 3.3. Criteria for determining the reliability of the results.
Topic 3.4. Evidence-based medicine.

Section 4. Statistical information processing, classification and forecasting, identification of connections.

Topic 4.1. Research of connections between objects.
Topic 4.2. Analysis of variance, regression analysis.
Topic 4.3. Spectral-correlation methods of analysis of biomedical signals.
Topic 4.4. Wavelet analysis.
Topic 4.5. Elements of pattern recognition.

Section 5. Image formation and analysis in biomedicine.

Topic 5.1. General characteristics of images. Sources of imaging in biomedicine.
Topic 5.2. Discrete images and features of their processing and analysis.
Topic 5.3. Image formats, relevant standards. File formats. DICOM.
Topic 5.4. Methods of processing and analysis of digital images, software.

Section 6. Physical principles and means of image formation in the infrared range.

Topic 6.1. Physical principles of obtaining images using infrared radiation. Infrared imaging methods.
Topic 6.2. Equipment for infrared imaging. Thermal imagers.
Topic 6.3. Clinical applications.

Section 7. Acoustic and ultrasound studies in biomedical engineering.

Topic 7.1. Brief information about physiological acoustics.
Topic 7.2. Fundamentals of ultrasound physics.
Topic 7.3. Generation of acoustic fields.
Topic 7.4. Fundamentals of ultrasound imaging.
Topic 7.5. Effects of ultrasound on biological objects.
Topic 7.6. Doppler ultrasound.

Section 8. Physical principles and means of electromagnetic research in biomedicine.

Topic 8.1. Principles and means of electrical measurements in biomedicine.
Topic 8.2. Principles and means of magnetic measurements in biomedicine.
Topic 8.3. Principles and means of research of electromagnetic radiation fluxes in biomedicine.
Topic 8.4. Examples of use in medicine.

Section 9. Features and basic principles of obtaining biomedical information through the use of X-rays, gamma- and nuclear radiation.

Topic 9.1. Physical principles of obtaining X-ray images.
Topic 9.2. Equipment for X-ray imaging.
Topic 9.3. Physical bases of obtaining images with the help of radioisotopes.
Topic 9.4. Positron emission tomography.

Section 10. Systems for displaying diagnostic information of different physical nature - acoustic, ultrasonic, optical.

Topic 10.1. Acoustic-electric converters.
Topic 10.2. Technical means of auscultation.
Topic 10.3. Phonocardiographs.
Topic 10.4. Audiometers.
Topic 10.5. Ultrasound diagnostics.
Topic 10.6. Optoelectronic converters.

Section 11 . Display diagnostic information systems of different physical nature - electro- magnetic , infrared, X-ray and gamma-

Topic 11.1. Electrocardiography.
Topic 11.2. Electroencephalography.
Topic 11.3. Electromyography.
Topic 11.4. Thermography.
Topic 11.5. X-ray and gamma- radiation receivers.

Section 12. Computed tomography.

Topic 12.1. Principles of image construction in X-ray computed tomography. Scan modes.
Topic 12.2. The structure of the computer tomograph.
Topic 12.3. Reconstruction of images in computed tomography.
Topic 12.4. Clinical applications of X-ray computed tomography.

Section 13. Magnetic resonance imaging.

Topic 13.1. Physical foundations of MRI.
Topic 13.2. Block diagram of MR tomograph.
Topic 13.3. Basic principles of image formation.
Topic 13.4. Gradients. Reading and phase-coding gradient.

Section 14. Positron emission tomography.

Topic 14.1. Physical basics.
Topic 14.2. Block diagram of PE tomograph.
Topic 14.3. Basic principles of image reconstruction.
Topic 14.4. Advantages and disadvantages of PET.
Topic 14.5. Clinical applications.

The term paper is the final control measure, which covers all program learning outcomes. Deadline: definition of the topic - up to the 3rd week, public defense - the 17th-18th week.

4. Training materials and resources

Basic literature

1. Eric J.Hall, Amato J.Giaccia. Radiobiology for the Radiologist. – Philadelphia: Wolters Kluwer, 2019. – 1161p. https://filesdo.com/b2f4187148758478

2. N.Smith, A.Webb. Introduction to Medical Imaging. – New York: Cambridge University Press, 2011. – 300p.: https://filesdo.com/0f91bc937cbbbeef?pt=wgXSuKpo9gyTI8wGqONIWW9rjay%2B3KE5yXw73nsJXew%3D

3. J.D.Bronzino. The Biomedical Engineering Handbook. – USA: Taylor & Francis Group, 2006. – 1404p. https://www.academia.edu/42026274/The_Biomedical_Engineering_Handbook_Third_Edition_Biomedical_Engineering_Fundamentals

Additional literature:

4. Основи реєстрації та аналізу біосигналів. Навчальний посібник / О.Г. Аврунін, В.В. Семенець, В.Г. Абакумов, З.Ю. Готра, С.М. Злепко, А.В. Кіпенський, С.В. Павлов. – Харків: ХНУРЕ, 2019. – 400 с. – Режим доступу: https://openarchive.nure.ua/bitstream/document/8514/3/Avruninbiosignal2019.pdf

5. Інтелектуальні технології в медичній діагностиці, лікуванні та реабілітації: монографія / [С. В Павлова, О.Г. Аврунінa, С.М.Злепка, Є.В.Бодянського та ін.]; за редакцією С.Павлова, О.Аврунінa. – Вінниця: ПП «ТД «Едельвейс і К», 2019. –260 с. – Режим доступу: https://openarchive.nure.ua/bitstream/document/8838/3/1Intel_Tech_Avrunin_2019.pdf

6. Біофізичні та математичні основи інструментальних методів медичної діагностики: Навч. Посібник / Є.В. Сторчун, Я.М. Матвійчук. – Львів: Вид. «Растр-7», 2009. – 216 с. – Режим доступу: http://ena.lp.edu.ua/bitstream/ntb/22788/3/InstrMetMedDiagn.pdf

7. Лукин А. Введение в цифровую обработку сигналов (математические основы). – М: МГУ, 2007. – 54 с. – Режим доступу: http://audio.rightmark.org/lukin/dspcourse/dspcourse.pdf

8. Лапач С.Н., Чубенко А.В., Бабич П.Н. Статистические методы в медико-биологических исследованиях с использованием Excel. – 2-е изд., перераб. и доп. – К.: МОРИОН, 2001. – 408 с. – Режим доступу: http://knigi.tor2.org/?b=1186162

9. Илясов Л.В. Биомедицинская измерительная техника: Учебное пособие для вузов. – М.: Высш. шк., 2007. – 342 с. – Режим доступу: http://www.booksmed.com/luchevaya-diagnostika/1278-biomedicinskaya-izmeritelnaya-texnika-ilyasov.html

10. Марусина М.Я., Казначеева А.О. Современные виды томографии. Учебное пособие. – СПб: СПбГУ ИТМО, 2006. – 132 с. – Режим доступу: http://books.ifmo.ru/file/pdf/118.pdf

11. Визильтер Ю.В., Желтов С.Ю., Князь В.А., Ходарев А.Н., Моржин А.В. Обработка и анализ цифровых изображений с примерами на LabVIEW IMAQ Vision. – М.: ДМК Пресс, 2007. – 464 с. – Режим доступу: http://www.torrentino.me/torrent/199549

12. Матвійчук А.О., Чеховой М.В., Кисельова О.Г., Шликов В.В., Яценко В.П. Методи клінічної діагностики та терапії. Методичні вказівки до виконання лабораторних робіт – К.: НТУУ „КПІ”, 2014. – 76 с. – Режим доступу: https://do.ipo.kpi.ua/pluginfile.php/286938/mod_resource/content/1/%21%21_Matvijchuk_KPI_Metody%20clinichnoyi%20diagnostyky.pdf

13. Physics of image visualization in medicine: in 2 volumes. Vol.1: Per. with English / ed. S. Webb. - M.: Mir, 1991. - 408 s.

14. Physics of image visualization in medicine: in 2 volumes. Vol.2: Per. with English / ed. S. Webb. - M.: Mir, 1991. - 408 s. - Access mode: http://www.booksmed.com/luchevaya-diagnostika/1551-fizika-vizualizacii-izobrazhenij-v-medicine-uyebb-stiv-monografiya.html

Information resources

1. Sikorsky distance learning platform. - Access mode: https://do.ipo.kpi.ua/course/view.php?id=2283

2. Forum on computer image processing. - Access mode: https://forums.ni.com/t5/Machine-Vision/bd-p/200.

3. LabVIEW User Club. - Access mode: http://www.labviewportal.org .

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The list of information resources lists the sources of their receipt.

Educational content

5. Methods of mastering the discipline (educational component)

№ s / n	Topic	Program learning outcomes	The main tasks	
			Control measure	Term implementation
1.	Introduction to the discipline. Discrete and continuous signals and images	PLO 1, 5, 6, 25	Practical work 1	1st week
2.	Digital signal and image processing	PLO 1, 2, 5, 6, 7	Practical work 2 -3	2nd week
3.	Data analysis tools in biomedicine. Evidence-based medicine	PLO 1, 2, 3, 4, 7	Practical work 4	3rd week
4.	Statistical information processing, classification and forecasting, identification of connections	PLO 1, 2, 3, 5, 7, 15, 24, 25	Practical work 5-6	4th week
5.	Image formation and analysis in biomedicine	PLO 1, 2, 3, 4, 5, 6, 7, 8, 9, 15, 24, 25	Practical work 7	5th week
6.	Physical principles and means of image formation in the infrared range	PLO 1, 2, 3, 4, 6, 7, 8, 9, 13, 15, 24, 25	Practical work 8-9	6th week
7.	Acoustic and ultrasound research in biomedical engineering	PLO 1, 2, 3, 4, 6, 7, 8, 9, 13, 15, 24, 25	Practical work 10	7th week
8.	Physical principles and means of electromagnetic research in biomedicine	PLO 1, 2, 3, 4, 6, 7, 8, 9, 13, 15, 24, 25	Practical work 11-12	8th week
9.	Features and basic principles of obtaining biomedical information through the use of X-ray, gamma and nuclear radiation	PLO 1, 2, 3, 4, 6, 7, 8, 9, 13, 15, 24, 25	Practical work 13	9th week
10.	Systems for displaying diagnostic information of different physical nature - acoustic, ultrasonic, optical	PLO 1, 2, 3, 4, 6, 7, 8, 9, 13, 15, 24, 25	Practical work 14-15	10th week
11.	Display diagnostic information systems of different physical nature - electro-magnetic, infrared, X-ray and gamma-	PLO 1, 2, 3, 4, 6, 7, 8, 9, 13, 15, 24, 25	Practical work 16	11st week
12.	Computed tomography	PLO 1, 2, 3, 4, 6, 7, 8, 9, 13, 15, 24, 25	Practical work 17 - 18	12th week
13.	Magnetic resonance imaging	PLO 1, 2, 3, 4, 6, 7, 8, 9, 13, 15, 24, 25	Practical work 19-20	13th week
14.	Positron emission tomography	PLO 1, 2, 3, 4, 6, 7, 8, 9, 13, 15, 24, 25	Practical work 21-22	14th week
15.	Modular control work	PLO 1-9, 15, 24, 25	Writing MCW	15th week
16.	Defense of course work	PLO 1-25	Defense of the TP	16-18th week

Distance learning platform:

For more effective communication in order to understand the structure of the discipline "Biomedical Information Display Systems" and master the material used e-mail, telegram channel, distance learning platform "Sikorsky" based on the Moodle KPI-Telecom system and online meeting service Zoom, whereby:

- increases the efficiency of communication with students, provides convenient feedback;

- simplifies the placement, access and exchange of educational material;

- students' learning tasks are evaluated ;

- student activity is analyzed.

6. Independent student work

Scheduled following types of independent work, preparation for classes, problem solving for practice work and registration statements, preparation for modular control work and exam, performance of term paper. A total of 76 hours are planned for independent work.

Regarding the implementation of the term paper - there is a separate syllabus with the recommended topics, relevant guidelines, implementation plan, grading system.

Policy and control

7. Policy of academic discipline (educational component)

Attending classes

The missed lecture can be completed during the week by writing a synopsis on the relevant topic and showing the teacher the mastery of the material. Otherwise the penalty point "-1" is applied.

Missed practical training can be performed and defended during the week without penalty points. Otherwise the penalty point "-1" is applied.

Control measures missed

Missed control measures (defense of practical work) must be practiced in subsequent classes, provided that the task is scheduled for the current lesson, or in consultations.

Omissions to write a modular test are not fulfilled.

Violation of deadlines and incentive points

Encouragement points		Penalty points*	
Criterion	Weight points	Criterion	Weight points
Improvement of practical work (for each such work)	+ 2 points	Untimely implementation and test of practical work	- 1 point
Passing distance courses on topics that are agreed with teacher	+ 5 points	Missed and not completed during the week lecture	-1 point for each lesson
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		

**** if the control measure was missed for a good reason (illness, which is confirmed by a certificate of the established sample) - penalty points are not accrued***

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 "Biomedical Information Display Systems" can be taught to most students with special educational needs, except for students with severe visual impairments who do not allow to perform tasks using personal computers, laptops and / or other technical means.

Distance Learning

Distance learning takes place through the Sikorsky Distance Learning Platform.

Distance learning 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 particular 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 distance course (in case of a full course) or provides completed practical tasks from the distance course and provided an interview with the teacher on the topics can receive grades for tests that are provided for the studied topics.

Performance of practical works, and also performance of modular control work can be 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.

At the 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. Types of control and rating system for assessing learning outcomes (Rating System of Evaluation)

Evaluation system (current control):

№ s / n	Control measure	%	Weight points	Number	Total
1.	Performance and defense of practice works	44	2	22	44
2.	Modular control work	16	16	1	16
3.	Exam	40	40	1	40
	Total				100

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

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
Term of calendar controls			8th week	14th week
Conditions for obtaining a positive result from the calendar control	Current rating		≥ 11 points	≥ 21 points
	Performing practical work	PW №№ 1- 11	+	+
		PW №№ 12 - 21	-	+
	Modular control work	Estimated MCR	-	-

In case of academic dishonesty during training - the control measure is not credited.

Semester certification of students

Mandatory condition for admission to the exam		Criterion
1	Current rating	RD ≥ 30
2	All practical works are protected	More than 27 points
3	Execution of modular control work	More than 10 points
4	Execution and defense of term paper	More than 60 points

The results are announced to each student separately in the presence on a control event or in a remote form (by e-mail, in the system "Sikorsky"). Also recorded in the "Electronic Campus" system.

Optional conditions for admission to the exam:

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

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

Number points	*Assessment on the university scale*
100-95	*Perfectly / 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*

The exam is performed in writing.
Students are allowed to use the following on the exam:
- computer with the IMAQ NI Vision package installed.

9. Additional information on the discipline (educational component)

The list of questions for preparation for modular control work, and also for preparation for exam is given in appendix 1.

The term paper is planned for the discipline "Biomedical Information Display Systems". For this purpose a separate syllabus with the recommended subject, the corresponding methodical recommendations, the plan of performance, system of estimations is provided.

Ability to enroll in certificates of distance learning

1. Online courses in the Moodle system

Distance learning through online courses in the Moodle system on certain topics is allowed subject to agreement with students. If a small number of students willing to go online course on a specific subject, study material through such courses is allowed but students have to complete all the tasks provided in the discipline (practical work, modular control work, TP).

2. Taking online courses on the Coursera platform

Students are offered courses on the Coursera platform, which give them the opportunity to obtain credits as blended or additional training, as well as to receive additional points in the discipline.

Courses from the Coursera for Campus catalog or online courses selected by students from the wider Coursera catalog complement the curriculum of the discipline. The list of distance courses is given on the website of the Department of Biomedical Engineering: http://bmi.fbmi.kpi.ua/non-formal-education

Work program of the discipline (syllabus) :

Compiled by: associate professor, PhD, Solomin Andriy Vyacheslavovich

Approved by the Department of Biomedical Engineering (protocol № 13 to 25.06. 2021);

Approved by the Methodical Commission of the Faculty of Biomedical Engineering (protocol № 11 to 25.06.2021)

Appendix 1 to the syllabus of the discipline

"Biomedical information display systems"

The list of questions for preparation for modular control work, as well as to prepare for the exam

Question I

1. *Analyze the principles, tools, sources of signals in biomedical engineering.*
2. *Reveal the concept of a linear stationary system in signal processing.*
3. *Explain the essence of Kotelnikov's theorem and its practical consequences.*
4. *Explain the essence of the phenomenon of aliasing in signal processing.*
5. *Reveal the concept of impulse response of the system and its use in signal processing.*
6. *Analyze the essence and use of the operation of convolution of the signal with the core.*
7. *Reveal the essence of signal correlation.*
8. *Explain the content and purpose of the Fourier transform for signals.*
9. *Analyze the signal filtering process.*
10. *Give examples of constructing a filter core by their frequency response.*

Question II

11. *Reveal the classification of scales for measuring quantities, namely scales of relations, interval, rank and nominal.*
12. *Give possible transformations of values in scales of relations, interval, rank and nominal.*
13. *Give and analyze the statistical characteristics of quantities.*
14. *Reveal the essence of methods for testing the validity of hypotheses in the analysis of measurement results.*
15. *Explain the nature of classification methods (cluster analysis, discriminant analysis).*
16. *Reveal the essence of correlation analysis.*
17. *Reveal the essence of analysis of variance.*
18. *Explain the essence of regression analysis in describing empirical relationships.*
19. *Analyze the role of statistical forecasting methods in biomedical practice.*
20. *Give and analyze examples of applications of evidence-based medicine in biomedical engineering.*

Question III

21. *Reveal the main image formats used in biomedicine.*
22. *Analyze the physical principles and means of image formation in the infrared range.*
23. *Explain the basic principles of visualization of acoustic and ultrasonic range information.*
24. *Describe the basic physical principles and means of electromagnetic research in biomedicine.*
25. *Analyze the features and basic principles of obtaining biomedical information through the use of X-rays, gamma- and nuclear radiation .*
26. *Describe the classes of sensors used to record biomedical signals.*
27. *Reveal the principles of computed tomography.*
28. *Analyze the physical basis of the functioning of magnetic resonance imaging.*
29. *Reveal the purpose and principles of positron emission tomography.*
30. *Give and analyze examples of applications of biomedical information visualization tools.*

Question IV. TASK (examples)

31. *Build and analyze an image histogram using Vision Assistant or IMAQ Vision .*
32. *Filter images from noise with Vision Assistant or IMAQ Vision .*
33. *Build a filter behind its core using Vision Assistant or IMAQ Vision, and analyze its operation.*
34. *Construct and analyze the image profile along a given line using Vision Assistant or IMAQ Vision .*

35. *Build and analyze image projection using Vision Assistant or IMAQ Visio.*
36. *Apply a frequency domain filter to the image and analyze its effect.*
37. *Select contours on the image using Vision Assistant or IMAQ Vision.*
38. *Apply mathematical morphology operations to the image using IMAQ Vision and analyze their effect.*
39. *Select connected areas in the image using IMAQ Vision.*
40. *Select a geometric primitive in the image using IMAQ Vision.*