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

Department
biomedical engineering

Fundamentals of design and engineering of medical equipment

Working program of basic discipline (Silabus)

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	*Mandatory discipline*
Form of study	*full-time / day / mixed / remote*
Year of preparation, semester	*4 course (spring semester)*
The scope of discipline	*4 ECTS credits / 120 hours*
Semester control / Control measures	*Test Work, abstract*
Lessons schedule	*According to the schedule on the site http://rozklad.kpi.ua/*
Language of instruction	*English*
Information about course leader / teachers	***Lecturer:*** *Doctor of Technical Sciences, Professor, Lebedev Alexey Vladimirovich, ph. 0955901559, bioowelding@gmail.com mmif@kpi.ua,* ***Practical:*** *Doctor of Technical Sciences, Professor, Lebedev Alexey Vladimirovich, ph. 0955901559, bioowelding@gmail.com mmif@kpi.ua,*
Course placement	*Platform «Sikorsky» - course «Medical Microprocessor Systems» (az72wi)*

Distribution of hours

Semester	Lectures	Practical	Laboratory	Independent Work
spring semester	*14*	*14*	*8*	*103*

Curriculum of the discipline

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

The discipline " Fundamentals of design and engineering of medical equipment " (hereinafter FDEE) is taught by a professor with 48 years of experience in scientific and practical work on the use of engineering and medical engineering tools and technologies.

The discipline belongs to the cycle of normative disciplines of professional training of bachelors. A is a new important discipline in engineering education. Many companies are developing high-tech products for present and future medicine. According to international educational programs, the theoretical content of disciplines includes the main problems at the intersection of engineering and medicine. The practical part is aimed at solving problems of analysis and design of electronic medical equipment.

The purpose of the discipline is to form students' abilities to analyze and design electronic systems using modern application packages for design, analysis, and synthesis of design solutions.

General competencies (*OPP was put into effect by the Rector's Order NON/ 89/2021 of 19.04.2021****):***

GC 1 - *Ability to abstract thinking, analysis, and synthesis.*

GC 2 - *Ability to search, process and analyze information from various sources.*

GC 6 - *Ability to search, process and analyze information from various sources.*

GC 7 - *Ability to generate new ideas (creativity)****.***

GC 9 - *Ability to communicate with representatives of other professional groups of different levels (with experts from other fields of knowledge / types of economic activity)*

Special (professional) competencies *(OPP was put into effect by the Rector's Order NON/ 89/2021 of 19.04.2021):*

PC 1 *- Ability to solve complex problems of biomedical engineering using the methods of mathematics, natural and engineering sciences.*

PC 3 *- Possession of modern methods of scientific research software, construction of adequate theoretical models and methods of their substantiation.*

PC 4 *- Application of calculation methods and selection of classical and new designs of biomaterials, elements of devices and systems of medical appointment.*

PC 5 *- Application of methods and tools for designing computer networks.*

PC *6 - Ability to search, process and analyze information from various sources.*

PC *7 - Ability to generate new ideas (creativity).*

PC 10 *- Ability to design and practical use of microcomputer and microprocessor systems in medical and diagnostic information and measuring equipment.*

PC 11*- Ability to evaluate design and technological, engineering and scientific and technical solutions in terms of compliance with safety conditions, energy efficiency and environmental friendliness. Willingness to use such assessments in engineering practice;*

PC 12 - *Ability to formulate the novelty and relevance of research work, to conduct a scientific discussion and present the results of research on a given topic in the field of principles of operation and methods of development of information and technological electronic systems.*

PC 13 *- Knowledge of a foreign language to an extent sufficient for general and professional communication.*

PC 14 - *Ability to conduct experiments according to specified technical and medical methods, perform computer processing, analysis and synthesis of the results.*

The program learning outcomes after studying the discipline "Electrical engineering and electronics" are (OPP was put into effect by the Rector's Order NON/ 89/2021 of 19.04.2021):

PLO 1 *- Understanding of fundamental-applied, medical, 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 - Ability to plan, design, develop, install, operate, maintain, control and coordinate the*

repair of devices, equipment and systems for prevention, diagnosis, treatment and rehabilitation used in hospitals and research institutes.

***PLO 8** - Knowledge of general requirements for the conditions of engineering, technological and scientific projects.*

***PLO** 10 - Ability to apply the principles of construction of modern automated control systems for the production of medical devices, their technical, algorithmic, informational and software for solving professional problems.*

***PLO 11**- Ability to evaluate design and technological, engineering, and scientific and technical solutions in terms of compliance with safety conditions, energy efficiency and environmental friendliness. Willingness to use such assessments in engineering practice;*

***PLO 12 -** Ability to formulate the novelty and relevance of research work, to conduct a scientific discussion and present the results of research on a given topic in the field of principles of operation and methods of development of information and technological electronic systems.*

***PLO 13** - Knowledge of a foreign language to an extent sufficient for general and professional communication.*

***PLO 14 -** Ability to conduct experiments according to specified technical and medical methods, perform computer processing, analysis and synthesis of the results.*

***PLO 16** - Knowledge of methods of design, construction, improvement and application of medical-technical and bioengineering products, devices and systems in compliance with technical requirements, as well as to support their operation.*

***PLO 17** - Analysis and solution of complex medical-engineering and bioengineering problems with the use of mathematical methods and information technologies.*

***PLO 19 -** Knowledge of technical documentation governing the commissioning, use and repair of medical equipment.*

***PLO 31 -** Understanding of theoretical and practical approaches to the creation and management of medical equipment and medical equipment.*

***PLO 36** - Analysis of signals transmitted from organs to devices, and receipt and processing of diagnostic information.*

***PLO 40** - Use of computer-aided design systems for development of technological and hardware scheme of medical devices and systems.*

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

The discipline " Fundamentals of design and engineering of medical equipment " belongs to the cycle of professional training and has an interdisciplinary nature. To successfully study the discipline "Fundamentals of design and engineering of medical equipment" it is necessary to study the following disciplines: "Biomedical Mechanics", "Engineering Mechanics", "Biothermodynamics and Mass Transfer", "Diagnostic Technology". The discipline "Fundamentals of design and engineering of medical equipment" is basic for such educational components as "Undergraduate practice", "Research practice", "Execution of a master's thesis".

3. The content of the discipline

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

Section 1. General information on the design and engineering of medical equipment

Subject 1.1. Basic standards for the design of biomedical devices. Design stages. Requirements for the technical task for design.

Subject 1.2. Review of 3D modeling programs. Basic information and methods of working with programs: MIMIX, Compass, Autodesk Inventor, 3D MAX.

Section 2. 3D modeling in SolidWorks and Fusion 360 environments

Subject 2.1. Basic technologies for creating 3D models.
Subject 2.2. Creating animation and motion research.
Subject 2.3. Creating photorealistic images of 3D models.
Subject 2.4. Creating assembly
Subject 2.5. Conversion of 3D models into drawings.

Section 3. Solving Problems of Material Resistance and Mechanics in SolidWorks and Fusion 360 Environments.

Subject 3.1. Basic information and techniques for working with the module SolidWorks Simulation and Fusion 360.
Subject 3.2. Application of SolidWorks and Fusion 360 for design of biomedical devices, devices and technologies.
Subject 3.3. Designing a prosthesis of the lower extremities.
Subject 3.4. Hip prosthesis design.
Subject 3.5. Preoperative prediction of stenting surgery and aneurysm treatment.
Subject 3.6. Design of body armor and helmet.
Subject 3.7. Design of equipment and technologies for pressure therapy (or lymphatic drainage, pneumo massage) and shock wave therapy.
Subject 3.8. Investigation of the frequency properties of the tympanic membrane.
Subject 3.9. Optimization of the model to achieve certain goals: minimum weight, service life, strength.
Subject 3.10. Modeling of thermal physics problems.

Section 4. Solving problems of liquid and gas flow in SolidWorks Flow Express, Flow Simulation environments.

Subject 4.1. Basic information and techniques work with the addition of SolidWorks Flow Express, Flow Simulation.
Subject 4.2. Examples of application of SolidWorks Flow Express, Flow Simulation for research and design of biomedical devices.
Subject 4.3. Study of blood flow in sclerosed vessels.
Subject 4.4. Solving problems of bio thermodynamics and mass transfer in devices and the human body.
Subject 4.6. Design of cooling systems in Solid Works and Fusion 360 environments.

Section 5. Using the EMS SolidWorks add-on for the design of biomedical devices and technologies

Subject 5.1. Basic information and techniques for working with the EMS SolidWorks Simulation module.
Subject 5.2. Examples of application of the EMS SolidWorks Simulation add-on for research and design of biomedical devices.
Subject 5.3. Design of devices for electrophoresis.
Subject 5.4. Design of devices for treatment by direct and alternating current.
Subject 5.5. Design of devices for treatment with a constant alternating magnetic field.
Subject 5.6. Design of microwave devices for treatment in oncology.

4. Training materials and resources

Basic literature:

1. *Лебедєв Олексій Володимирович, Дубко Андрій Григорович. Методичні вказівки до виконання практичних робіт з кредитного модуля «Проектування біотехнічних систем» для напряму підготовки 6.051402 – «Біомедична інженерія» / КПІ ім. Ігоря Сікорського Електронні текстові данні. – Київ: КПІ ім. Ігоря Сікорського, 2017.*
2. *Лебедєв Олексій Володимирович, Дубко Андрій Григорович. Методичні вказівки до виконання практичних робіт з кредитного модуля «Основи конструювання і проектування» - з дисципліни «Основи клінічної інженерії - 1» для напряму підготовки 6.051402 – «Біомедична інженерія» К.: НТУУ «КПІ», 2015.–205с. Електронне видання http://ela.kpi.ua/handle/123456789/11764*
3. *Лебедєв Олексій Володимирович, Дубко Андрій Григорович. Методичні рекомендації до самостійної роботи студентів з дисципліни «Експертиза та інженерний супровід медичного обладнання» для напряму підготовки 6.051402 – «Біомедична інженерія» [Електронний ресурс] / КПІ ім. Ігоря Сікорського Електронні текстові данні. – Київ: КПІ ім. Ігоря Сікорського, 2017.*
4. *А. В. Чураков. Принципы моделирования и проектирования приборов магнито ультразвуковой терапии : учеб.-метод. пособие / А. В. Чураков. – Минск : БГУИР, 2019. – 146 с. : ил.*
5. *Ершов, Ю. А. Биотехнические системы медицинского назначения. В 2 ч. Часть 1. Количественное описание биообъектов : учебник для бакалавриата и магистратуры / Ю. А. Ершов, С. И. Щукин. — 2-е изд., испр. и доп. — М. : Издательство Юрайт, 2017. — 180 с. — Серия : Бакалавр и магистр. Академический курс.*
6. *Курушин А.А. Решение мультифизических СВЧ задач с помощью САПР COMSOL– М., «One-Book», 2016, 376 стр*
7. *Lydia Cline. Fusion 360 for Makers. Maker Media. San Francisco, 2019, p. 540.*

Additional literature:

1. *Графическое оформление электрических схем по ЕСКД . Сост. С.Т. Усатенко, М.В. Терехова; Предисл. и науч. ред. М.С. Хойнацкого. К.: ЛВК, 2003. -216 с.*

2. *Методические указания для освоения модуля "Лабораторный практикум по геометрическому моделированию в САПР Solid Works" по курсу "Геометрическое моделирование в конструировании инженерных объектов и систем" для студ. спец. 7.080402 - "Информационные технологии проектирования" всех форм обучения / Сост. С.В. Красников . Х.: НТУ "ХПИ", 2007. - 76 с.*

3. *В. В. Шевченко, О. В. Осадчий, М. О. Симута. Технологія приладобудування: навчальний посібник для студентів напрямку підготовки 6.051003 «Приладобудування», спеціальності «Наукові, аналітичні та екологічні прилади та системи» / Київ: НТУУ «КПІ», 2010. Електрона версія*

4. *Гурин Л.Б., Нестеренко Т.Г., Плотников И.А. Основы проектирования механизмов приборных систем: - Томск, Изд-во Томского политехнического университета, 2009. – 337 с.*

Educational content

5. Methods of mastering the discipline (educational component)

№ s/n	Subject	Program learning outcomes	The main tasks	
			Control measure	Deadline
Spring semester, 4 ECTS credits / 120 hours				
1.	***General information on the design and***	PLO 1	Practical work 1	1rd week

	engineering of medical equipment. *Basic standards for the design of biomedical devices. Design stages. Requirements for the technical task for design.*	*PLO 2* *PLO 3*		
2.	*Review of 3D modeling programs. Basic information and methods of working with programs: MIMIX, Compass, Autodesk Inventor, 3D MAX.*	*PLO 3* *PLO 40*	*Practical work 2*	*2th week*
3.	***3D modeling in SolidWorks and Fusion 360 environments.*** *Basic technologies for creating 3D models.*	*PLO 2* *PLO 3*	*Practical work 3-6*	*3-6th weeks*
4.	*Creating animation and motion research.*	*PLO 7*	*Practical work 7*	*7th week*
5.	*Creating photorealistic images of 3D models.*	*PLO 8*	*Practical work 8*	*8th week*
6.	*Creating assembles.*	*PLO 9*	*Practical work 9*	*9th week*
7.	*Conversion of 3D models into drawings.*	*PLO 10*	*Practical work 9*	*9th week*
8.	***Solving Problems of Material Resistance and Mechanics in SolidWorks and Fusion 360 Environments.*** *Basic information and techniques for working with the module SolidWorks Simulation and Fusion 360.*	*PLO 31*	*Practical work 10*	*10th week*
9.	*Application of SolidWorks and Fusion 360 for design of biomedical devices, devices and technologies.*	*PLO 40*	*Practical work 10*	*10th week*
10.	*Designing a prosthesis of the lower extremities.*	*PLO 5*	*Practical work 11*	*11th week*
11.	*Hip prosthesis design.*	*PLO 36*	*Practical work 11*	*11th week*
12.	*Preoperative prediction of stenting surgery and aneurysm treatment.*	*PLO 9*	*Practical work 12*	*12th week*
13.	*Design of body armor and helmet.*	*PLO 8*	*Practical work 12*	*12th week*
14.	*Design of equipment and technologies for pressure therapy (or lymphatic drainage, pneumo massage) and shock wave therapy.*	*PLO 36*	*Practical work 12*	*12th week*
15.	*Investigation of the frequency properties of the tympanic membrane.*	*PLO 36*	*Practical work 136*	*13th week*
16.	*Optimization of the model to achieve certain goals: minimum weight, service life, strength*	*PLO 8*	*Practical work 13*	*13th week*
17.	*Modeling of thermal physics problems.*	*PLO 8*	*Practical work 13*	*13th week*

18.	***Solving problems of liquid and gas flow in SolidWorks Flow Express, Flow Simulation environments.*** *Basic information and techniques work with the addition of SolidWorks Flow Express, Flow Simulation.*	*PLO 40*	*Practical work 14*	*14th week*
19.	*Examples of application of SolidWorks Flow Express, Flow Simulation for research and design of biomedical devices.*	*PLO 10*	*Practical work 14*	*14th week*
20.	*Study of blood flow in sclerosed vessels.*	*PLO 19*	*Practical work 15*	*15th week*
21.	*Solving problems of bio thermodynamics and mass transfer in devices and the human body.*	*PLO 31*	*Practical work 16*	*16th week*
	Design of cooling systems in Solid Works and Fusion 360 environments.	*PLO 14*	*Practical work 16*	*16th week*
	Using the EMS SolidWorks add-on for the design of biomedical devices and technologies. *Basic information and techniques for working with the EMS SolidWorks Simulation module.*	*PLO 8*	*Practical work 16*	*16th week*
	Examples of application of the EMS SolidWorks Simulation add-on for research and design of biomedical devices.	*PLO 7*	*Practical work 16*	*16th week*
	Design of devices for electrophoresis.	*PLO 12*	*Practical work 17*	*17th week*
	Design of devices for treatment by direct and alternating current.	*PLO 13*	*Practical work 17*	*17th week*
	Design of devices for treatment with a constant alternating magnetic field.	*PLO 6*	*Practical work 18*	*18th week*
	Design of microwave devices for treatment in oncology.	*PLO 4*	*Practical work 18*	*18th week*
22.	*Abstract*	*PLO 1*	*Registration and submission of work*	*18th week*
23.	*Modular control work*	*PLO 10-19*		*18th week*
24.	*Test*			*19th week*

6. Independent student work

One of the main types of semester control during the mastering of the discipline " Fundamentals of design and engineering of medical equipment " is the implementation of calculation and graphic work. Calculation and graphic work is performed in accordance with the requirements, within the period specified by the teacher.

The main purpose of computational and graphic work is to solve a practical problem using the material learned in lectures and independently, and practical skills acquired in practical work. The

student can write calculation and graphic work only on the subject agreed with the teacher.

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

The title page is followed by a detailed plan (content) of the calculation and graphic work, which should highlight the introduction, sections of the main content (main topics studied), their subdivisions (if necessary), conclusion, list of sources used. The table of contents on the right indicates the page numbers at the beginning of each question. Each section begins on a new page.

The total amount of calculation and graphic work, depending on the chosen topic can vary from 25 to 40 pages of the main text (in consultation with the teacher). The amount of computational and graphic work is determined by the student's ability to briefly and at the same time comprehensively explain and analyze the program code in the Code Composer Studio environment.

Mandatory requirement: clear reference to sources of information. All figures, facts, opinions of scientists, quotations, formulas should have a reference in the form [2, p. 54] (the first digit means the number of the source in the list of references given at the end of the creative work, and the second digit - the page number in this source). It is desirable to use tables, diagrams, graphs, charts, etc. The list of used sources (not less than 10 sources) is made out according to operating rules. If the information is taken from the Internet, you need, as for ordinary literature, specify the author, the title of the article, and then provide the address of the site on the Internet.

Calculation and graphic work is evaluated by the following criteria: logic of the plan; completeness and depth of topic disclosure; reliability of the received data; reflection of practical materials and results of calculations; correctness of formulation of conclusions of the received results and conclusions; design; substantiation of the student's own opinion on this issue in the form of a conclusion.

Deadline for submission of calculation and graphic work for verification: 7-8th week of study.

Calculation and graphic work is not tested for plagiarism, but must meet the requirements of academic integrity. In case of academic dishonesty, the work is canceled and not checked.

Policy and control

7. Policy of academic discipline (educational component)

Attending classes

Attendance at lectures is optional. Attending practical classes is desirable, as they are used to write express tests / tests, as well as to defend 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 (defense of practical work) must be practiced in the next classes, provided that the task is scheduled for the current lesson, or in consultations.

Omissions 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.

Violation of deadlines and incentive points

Encouragement points		Penalty points *	
Criterion	Weight points	Criterion	Weight points
Improving practical work	1 points (for each practical work)	Untimely implementation and test of practical work	From -0.5 points to -5 points (depending on the delivery date)
Passing distance courses on topics that are agreed with teachers	5 points	Untimely execution and test of calculation and graphic work	From -2 points to -20 points (depending on the construction period)
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 " Analysis and design of electronic medical equipment " 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 «Sikorsky».

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 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.

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

Evaluation system (current control):

Spring semester, 4 ECTS credits / 120 hours

№ 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	32	2	16	52
4.	Modular control work (MCW)	12	12	1	12
5.	Abstract	15	15	1	15
6.	Test work[1]	80	80	1	80
	Total				120

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

[1] *Taken into account in the amount of the rating together with the grade for CGW in case the student has not scored 60 points per semester or he wants to improve his grade.*

implementation of the schedule of the educational process by students.

Criterion			The CC	
Deadline of calendar controls			8th week	16th week
Conditions for obtaining a positive result from the calendar control	Current rating		≥ 24 points	≥ 24 points
	Execution practical work	PW № 1- 8	+	+
		PW № 9-16	-	+
	Execution of modular works	LW № 1- 4	+	-
		LW № 5- 9	-	+
	Express control works / test tasks	At least 4 of any lectures	+	-
		At least 8 of any lectures	-	+
	Modular control work	Estimated MCW	-	+
	Abstract	Estimated CGW	-	+

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 calculation and graphic work	More than 8 points
3	All practical works are tested	More than 14 points
4	Writing at least 6 express tests / tests	More than 6 points

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

Optional conditions for admission to closure:

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

Table of translation of rating points to grades on a 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

9. Additional information on the discipline (educational component)

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

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 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).

Work program of the discipline (syllabus):

Compiled by *Associate Professor of Biomedical Engineering, Doctor of Technical Sciences, Lebedev Alexei*

Approved by *the Department of Biomedical Engineering (protocol № ___ to _____)*

Approved by *the Methodical Commission of the Faculty of Biomedical Engineering (protocol № __ to _____)*

Appendix 1 to the syllabus of the discipline

" Fundamentals of design and engineering of medical equipment "

The list of questions for preparation for modular control work,

and, for preparation for test

1. Basic standards for the design of biomedical annexes.
2. Design stages.
3. Requirements for the technical task for design.
4. Basic technology of 3D models.
5. Preceding blood loss in sclerosed judgment.
6. Apply a SolidWorks Flow Express Flow Simulation solution for advanced and design biomedical annexes.
7. Basic information and robots with EMS SolidWorks Simulation module.
8. Modeling the tasks of thermal physics.
9. Optimization of the model for the achievement of singing goals: minimum mass, resource, performance.
10. Design of body armor and helmets.
11. Design of the prosthesis of the shank slope.
12. The design of annexes for the use of a permanent wintry magnetic field.