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

Department of
biomedical engineering

Diploma design

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	***Normative discipline***
Form of study	***full-time / day / mixed / remote***
Year of preparation, semester	***4th course, Spring semester***
The scope of discipline	***6 ECTS credits / 180 hours***
Semester control / Control measures	***Thesis defense***
Lessons schedule	***180 hours - independent work***
Language of instruction	***English***
Information about course leader / teachers	***Lecturer: Associate Professor,Bogomolov Mykola,*** nbogom@yahoo.com; mfbogomolov@gmail.com; m.bogomolov@kpi.ua ***Practical: Associate Professor,Bogomolov Mykola,*** nbogom@yahoo.com; mfbogomolov@gmail.com; m.bogomolov@kpi.ua ***Zoom: 779 2233 9663, code 7Pzg7d***
Teacher's profile	***Lecturer:*** **http://intellect.bmi.fbmi.kpi.ua/profile/bmf**
Course placement	***https://campus.kpi.ua***

Distribution of hours

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* ***"Diploma Design"*** *is the formation of students' ability to design technical objects that meet the established source data; perform feasibility study of decisions taken; make decisions that correspond to the latest advances in science and technology; apply modern methods of analysis and calculation of components of design objects; reasonably choose methods and conduct research / experiments, analyze the results; effectively use modern information technologies; perform design documentation in accordance with regulatory requirements. Mastering the methodology of creative solution (solution) of modern problems (tasks) of scientific or (and) applied nature on the basis of acquired knowledge and professional skills in accordance with the requirements of higher education standards.*

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).

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

***GC 1** - Ability to apply knowledge in practical situations.*

***GC 2** - Knowledge and understanding of the subject area and understanding of professional activity.*

***GC 4** - Skills in the use of information and communication technologies.*

***GC 5 -** Ability to perform research at the appropriate level.*

***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).*

***GC 11** - Ability to evaluate and ensure the quality of work performed.*

***GC 12 -** Ability to realize their rights and responsibilities as a member of society, to appreciate the values of civil (free democratic) society and the need for its sustainable development, the rule of law, rights and freedoms of human and of Ukrainian citizen.*

***GC 13 -** Ability to preserve and increase 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, technics and technology, use different types of physical activity for active recreation and a healthy lifestyle.*

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

***PC 2** - Ability to provide engineering expertise in the process of planning, development, evaluation and specification of medical equipment.*

***PC 4** - Ability to provide technical and functional characteristics of systems and tools used in medicine and biology (in prevention, diagnosis, treatment and rehabilitation).*

***PC 5** - Ability to apply physical, chemical, biological and mathematical methods in the analysis, modeling of the functioning of living organisms and biotechnical systems.*

***PC 7**- Ability to plan, design, develop, install, operate, exploit, maintain, control and coordinate the repair of devices, equipment and systems for prevention, diagnosis, treatment and rehabilitation used in hospitals and research institutes.*

***PC 9** - Ability to improve research and observations on the interaction of biological, natural and artificial systems (prostheses, artificial organs, etc.).*

***PC 12 -** 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.*

***PC-14 -** Ability to improve 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 "Microprocessor Engineering" are (OPP was put into effect by the Rector's Order NON/ 89/2021 of 19.04.2021):

PLO 2 *- Possession of engineering methods for calculation of elements of devices and systems of medical use and a choice of classical and newest constructional materials.*

PLO 3 - *Knowledge of design tools for devices, appliances and systems of medical and biological purposes.*

PLO 4 - *Knowledge of methods of designing of digital and microprocessor systems for medical purposes.*

PLO 5 - *Knowledge of research methods and techniques used in the design of medical equipment.*

PLO 6 – *Knowledge of object research methods, analysis and processing of experimental data.*

PLO 7 – *Understanding of scientific and technical principles that underlie the latest advances in biomedical engineering.*

PLO 10 – *Knowledge of the basic physical and physicochemical patterns of biological objects functioning.*

PLO 13 - *Use of methods and means of systematization and processing of experimental information.*

PLO 22 *- Use methods of statistical processing, modeling and simulation of processes and systems of physical and biological nature in biomedical engineering.*

PLO 28 - *Use of databases, mathematical and software for data processing and computer modeling of biotechnical systems.*

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

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

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

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

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

(projector and electronic presentations for lectures and practical classes).

The subject of the discipline "Diploma Design" is a thesis.

Program learning outcomes: As a result of studying the discipline ***"Diploma Design"*** students will be able to:

1. Choose the basic and auxiliary materials, methods and tools for the implementation of technical projects, to apply modern methods and methods of modeling in the design of medical equipment and medical devices.
2. Use methods and means of quantitative assessment of the functioning of physiological systems in practical engineering activities.
3. Implement modern diagnostic and treatment methods related to the use of biotechnology, computer and nanotechnology.
4. Conduct experiments according to specified technical and medical methods, perform computer processing, analysis and synthesis of the results
5. Implement modern diagnostic and therapeutic methods related to the use of biotechnology, computer and nanotechnology.
6. Improve the technical elements of medical devices and systems in the process of professional activity.
7. Apply methods and tools for forecasting and modeling to study the behavior and properties of biological systems.
8. Work with information: find, evaluate and use information from various sources needed to solve scientific and professional problems.

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

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

The discipline ***"Diploma Design"*** 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 ***"Diploma Design"*** 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 *"Diploma Design"*

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

№		***Program***	***The main tasks***

s/n	Subject	learning outcomes	Control measure	Deadline
1.	General concepts about the development of medical devices	PLO 2 PLO 5 PLO 10	Practical work 1, 2	3rd week
2.	Basic medical and technical requirements for the development of medical devices	PLO 4 PLO 5 PLO 6 PLO13	Practical work 3,4	4th week
3.	System analysis of biomedical equipment design.	PLO 6 PLO 7 PLO 10	Practical work 5-8	5-6th weeks
4.	Technical support for the development of medical devices.	PLO 3 PLO 22 PLO 28	Practical work 9-10	7-8th weeks
5.	Mathematical support for the design of BM REA.	PLO 6 PLO 7 PLO 10	Practical work 11-12	9-10th weeks
6.	Complex of means of automated design of biomedical equipment.	PLO 4 PLO 22 PLO 31	Practical work 13-14	11-12th weeks
7.	Scientific and methodological principles of designing biomedical equipment.	PLO 2 PLO 5 PLO 10	Practical work 15-18	13-14th weeks
8.	Basic safety requirements for the design of medical devices.	PLO 3 PLO 5 PLO 10	Registration and submission of Diploma Work	15-16th weeks
9.	List of normative documents on introduction and operation of medical equipment.	PLO 4 PLO 28 PLO 36	Thesis defense	17-18th weeks

The main tasks of diploma design: - systematization, consolidation and expansion of theoretical knowledge obtained in the process of studying for a bachelor's degree program, and their practical use in solving specific engineering, scientific, economic, social and industrial issues in a particular field of professional activity;

- development of experience in independent work, mastering the methods of research and experimentation, physical or mathematical modeling, the use of modern computer technology in the development and design of modern biomedical equipment, which are provided for the task of certification work;

- determining the compliance of the level of training of the applicant with the requirements of the educational program, his readiness and ability to work independently in a market economy, modern production, progress of science, technology and culture.

The bachelor's thesis should be based on the knowledge and skills acquired in the study of disciplines for the entire period of study, and may be based in part on the results of course design.

4. Training materials and resources

Basic literature:

1. ЗАКОН УКРАЇНИ Про вищу освіту (Відомості Верховної Ради (ВВР), 2014, №37-38, ст.2004) Редакція від 02.09.20120 http://zakon2.rada.gov.ua/laws/show/1556-18
2. ПОЛОЖЕННЯ про випускну атестацію студентів КПІ ім. Ігоря Сікорського/ Уклад.: В.П.Головенкін, В.Ю.Угольніков. – Київ, КПІ ім. Ігоря Сікорського, 2018. – 100 с. https://kpi.ua/files/n7437.pdf
3. Положення про організацію освітнього процесу в КПІ ім. Ігоря Сікорського - https://document.kpi.ua/files/2020_7-124.pdf
4. Оформлення текстових документів у навчальному процесі. Стандарт організації (кафедри) СОУ АУТС 01-15. Для студентів кафедри автоматики та управління в технічних системах [/ Уклад.: Я.Ю. Дорогий, Н.Б. Репнікова, О.І. Ролік, Л.Ю. Юрчук – К.: НТУУ «КПІ», 2015. – 27 с. (Редакція 2018 р.)
5. ***Additional literature:***
6. ДСТУ 8302:2015. Бібліографічне посилання. Загальні положення та правила складання. Київ, 2016. 17 с. (Інформація та документація).
7. ДСТУ 3582:2013. Скорочення слів і словосполучень українською мовою. Загальні вимоги та правила. Київ, 2014. 14 с.

Electronic resources:

1. http://info-library.com.ua/books-text-4072.html.
2. http://www.twirpx.com.
3. **Electronic campus. Teacher MF Bogomolov.**
4. http://info-library.com.ua/books-text-4072.html.
5. http://www.twirpx.com.
6. http://ela.kpi/handle/123456789/7739 .
7. http://info-library.com.ua/books-text-4072.html .
8. http://ela.kpi/handle/123456789/11560.
9. http://ela.kpi.ua/handle/123456789/16554.

Educational content

5. Methods of mastering the discipline (educational component)

Organizationally, the process of certification work consists of the following stages: - *preparatory*, which begins with the student's choice of topic and receiving an individual task from the teacher on issues to be solved during undergraduate practice on the chosen topic (acquaintance with the problem, collecting factual materials, conducting necessary observations, experiments, research, etc.), includes mastering undergraduate practice program and ends with the preparation and defense of a report on its completion;

- *the main one*, which begins immediately after the defense of the internship report and ends approximately two weeks before the defense of the thesis, when the thesis is submitted for preliminary defense. At this stage, the certification work must be fully performed, verified by the head and consultants;

- *final*, which includes receiving feedback from the supervisor and a review. Completed attestation works with the response of the head are submitted by students to the graduating department not later than ten days before the day of defense in the examination commission (EC). The head of the department based on the results of the interview with the student and acquaintance with the submitted materials makes a decision on admission to the defense and puts a visa on the title page of the student's certification work. The decision of the head of the department is made out by the corresponding protocol of meeting of department. Thesis consists of a text part and a graphic part. The text part of the work should in a concise and clear form reveal the creative idea of the work, contain an analysis of the current state of the problem, methods of solving problems, substantiation of their optimality, methods and results of calculations, description of experiments, analysis of their results and conclusions; contain the necessary illustrations, sketches, graphs, charts, tables, diagrams, figures, etc. It should be free of well-known provisions, redundant descriptions, derivation of complex formulas, and so on. The graphic part contains a presentation of the main results of the work and their approbation (schemes, diagrams, etc.). The final stage is preparation for the speech at the meeting of the examination commission and the procedure of defense of the thesis. Structurally, the student's report at the EC meeting can be divided into three parts, each of which represents an independent content block, but in general they are logically related and characterize the content of the study. In the first part of the report it is necessary to present the topic of work, to characterize the relevance of the chosen topic, to give a description of the problem, as well as to formulate the purpose and objectives of the work. The second, largest part, in the sequence established by the logic of the study, characterizes each section of the work. At the same time, special attention is paid to the methods by which the actual material was obtained and the final results. The report ends with the final part, which presents the general conclusions.

Distance learning platform: For more effective communication in order to understand the structure of the discipline ***"Diploma Design"*** 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 of the discipline "Diploma Design"***

№ s/n	Names of topics and questions submitted for self-study and references to educational literature	Hours ISW
1	**Review and analysis of existing solutions on the topic of the thesis work**	**25**
2	**Description of the subject environment. Definition of the subject and tasks of diploma design.**	**35**
3	**Definition of input and output data. Definition of methods and means for solving diploma design problems**	**20**
4	**Description of the database structure. Development of a system or subsystem. Development of information base. Detailed design of system elements.**	**25**
5	**Creating system software. Creation of graphic materials for the thesis.**	**25**
6	**Writing and drawing up an explanatory note to the thesis.**	**25**
7	**Preparation of a report and presentation for the defense of the thesis.**	**25**

№ s/n	Names of topics and questions submitted for self-study and references to educational literature	Hours ISW
Total hours		**180**

Policy and control

7. Policy of academic discipline (educational component)

Attending classes

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

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

Control measures missed

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

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 ***"Diploma Design"*** *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.

The student must:

• timely choose the topic of the thesis and get a preliminary task for the SE and recommendations from the supervisor on the selection and processing of materials during the undergraduate practice;

• regularly, at least once a week, inform the supervisor about the status of the thesis in accordance with the calendar plan, provide at his request the necessary materials for inspection;

• independently perform an individual thesis or individual part of a complex work;

• when developing issues to take into account modern achievements of microcomputer science and technology, to use advanced methods of scientific and experimental research, to make reasonable and optimal decisions using a systematic approach;

• be responsible for the correctness of decisions, justifications, calculations, quality of text and graphic material, their compliance with the methodological recommendations of the graduating department for the performance of certification work, existing regulations and standards of higher education;

• adhere to the work schedule, established rules of conduct in scientific laboratories and classrooms, timely and adequately respond to comments and recommendations of the head and consultants of the SE;

• within the established term to submit the diploma work for check to the head and consultants and after elimination of their remarks to return to the head for receiving its response;

• get all the necessary signatures on the title page of the work, as well as the resolution of the head of the graduating department on admission to the defense;

• personally submit the thesis admitted to the defense to the reviewer; at his request to provide the necessary explanations on the issues being developed;

• to get acquainted with the content of the supervisor's response and review and to prepare (if necessary) reasoned answers to their remarks in the defense of the thesis in the examination commission (EC). It is forbidden to make any changes or corrections to the attestation work after receiving the supervisor's response and review;

• pass the preliminary defense at the department;

• to submit to the department a diploma work prepared and admitted to the defense with the response of the head and a review not less than ten days before his defense in the examination commission;

• arrive in time to defend the thesis or warn the head of the graduating department and the head of the EC (through the Secretary of the EC) about the impossibility of attending the defense, stating the

reasons for this and subsequent submission of documents certifying the validity of the reasons. In the absence of such EC documents, a decision may be made not to certify it as one that did not appear in defense of the thesis without good reason, with subsequent expulsion from the university. If the student was not able to warn in advance about the impossibility of his presence at the defense, but during the EC provided the necessary supporting documents, the EC may postpone the date of defense.

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

The rating of a student in the defense of the thesis consists of points that he receives for: Criteria for assessing the quality of the thesis 1. Approbation of the work and its practical value 2. Validity of the purpose and choice of research methods 3. Modernity and originality of decisions 4. The level of use of information technology 5. The level of experimental verification of decisions 6. The level of execution of additional sections 7. Quality of work design Criteria for assessing the defense of the thesis 8. Quality of report presentation 9. Quality of the report 10. Ability to lead a scientific discussion.

System of rating (weight) points and evaluation criteria

Criteria for assessing the quality of the thesis

1. ***Approbation of work and its practical value***. **Weight score – 10**

Evaluation criterion with the definition of four levels:

"Excellent" -- The work is done according to interests or the results are implemented in the educational process of the department OR Several scientific articles and / or abstracts of reports at scientific conferences or seminars have been published. Published works relate to the completed thesis. **10 points**

"Good"-- The work is performed on the basis of real initial data OR One scientific article and / or abstract of the report at scientific conferences or seminars is published. The published work relates to the completed thesis**. 9-8 points**

"Satisfactory" -- The work is purely educational OR received a recommendation from the EC on the implementation or publication of results. **7-6 points**

"Unsatisfactory" -- There is no practical orientation and implementation of the results of the work. **0 points.**

2. ***Validity of the purpose and choice of research methods***. **Weight score – 10**

Evaluation criterion with the definition of four levels:

"Excellent" -- The purpose of the study is relevant and well-founded. Deeply, according to many criteria, acceptable methods of research are considered. The choice of theoretical and experimental research methods is made on the basis of clearly defined tasks and a systematic approach. **10 points**

"Good"-- The purpose of the study is relevant but not sufficiently substantiated. Several possible theoretical and / or experimental research methods are considered. Based on one of the criteria, the best method was chosen. **9-8 points**

"Satisfactory" -- The purpose and objectives of the study are not substantiated. The choice of research method was made without sufficient justification. **7-6 points**

"Unsatisfactory" -- Does not meet the criterion "Satisfactory" **0 points.**

3. ***Modernity and originality of decisions***. **Weight score – 10**

Evaluation criterion with the definition of four levels:

"Excellent" -- The decision was made on the basis of the analysis of the newest domestic and foreign (far abroad) scientific, scientific-technical and patent literature. **10 points**

"Good"-- The decision was made on the basis of the analysis of domestic (and / or one of the CIS countries) scientific, scientific-technical and patent literature. **9-8 points**

"Satisfactory" -- The main decisions were made without sufficient analysis of the current state of the issue. **7-6 points**

"Unsatisfactory" -- Does not meet the criterion "Satisfactory" **0 points.**

4. ***The level of use of information technology***. **Weight score – 10**

Evaluation criterion with the definition of four levels:

"Excellent" -- The solution of research problems is carried out on the basis of use of several modern programs (CAD / CAM / CAE / MatCAD / MatLab / Mathematical / Statistica / SPSS / Stat graphics Plus and others) OR other high-level application software packages OR the decision of research problems is carried out at the expense of independent software development products. The choice of programs is justified. **10 points**

"Good"-- The solution of research problems is carried out on the basis of use of only one of software packages of the decision of engineering and scientific problems. The choice of the program is justified. **9-8 points**

"Satisfactory" -- Information technology is used to perform basic calculations and at the level of use of office programs. **7-6 points**

"Unsatisfactory" -- Does not meet the criterion "Satisfactory" **0 points.**

5. ***The level of experimental verification of decisions***. **Weight score – 10**

Evaluation criterion with the definition of four levels:

"Excellent" An original method of full-scale or virtual experiment has been developed on the basis of real data OR an experimental setup has been created. The research was conducted at the modern technical and methodological level. The comparative analysis of theoretical and experimental results is carried out. **10 points**

"Good"-- The choice of the method of full-scale or virtual experimental research using theoretical data is quite justified. The research was conducted at the modern technical and methodological level. The results were analyzed and conclusions were made. **9-8 points**

"Satisfactory" -- The ability to justify the choice of the method of full-scale or virtual experimental research is demonstrated. The results were analyzed and conclusions were made. **7-6 points**

"Unsatisfactory" -- Does not meet the criterion "Satisfactory" **0 points.**

6. ***The level of execution of additional sections.*** **Weight score – 10**

Evaluation criterion with the definition of four levels:

"Excellent"-- When designing the object (device, technology), the requirements of safety and labor protection are solved in the form of specific technical solutions, which are supported by appropriate calculations. **10 points**

"Good"-- In additional sections, the material is informative. The main requirements are partially implemented in the main part of the project. **9-8 points**

"Satisfactory" -- Additional sections are formal, and their content is weakly related to the main part of the project. **7-6 points**

"Unsatisfactory" -- Does not meet the criterion "Satisfactory" **0 points.**

7. ***Quality of work design.*** **Weight score – 10**

Evaluation criterion with the definition of four levels:

"Excellent"-- The material is set out clearly, concisely, clearly, the design of the work fully meets the requirements of the methodological recommendations for diploma design developed in accordance with DSTU 3008: 2015. **10 points**

"Good"-- The material is clear, concise, but there are stylistic errors. Design with minor deviations from the requirements of the methodological recommendations for diploma design developed in accordance with DSTU 3008: 2015. **9-8 points**

"Satisfactory" -- Fuzzy presentation of the material, there are grammatical errors. Registration with violations of the requirements of methodical recommendations for diploma design developed in accordance with DSTU 3008: 2015. **7-6 points**

"Unsatisfactory" -- Does not meet the criterion "Satisfactory" **0 points.**

8. ***Quality of report presentation.*** Weight score – 10

Evaluation criterion with the definition of four levels:

"Excellent"-- The presentation fully, with high clarity, reveals the main provisions of the work submitted for defense. The material is presented clearly, concisely, in competent Ukrainian. The presentation is made with the help of modern graphic packages in compliance with the requirements of regulatory documents. **10 points**

"Good"-- The presentation fully, but with insufficient clarity, reveals the main points of the work. The material is clear, concise, but there are stylistic flaws. The presentation is made with the help of modern graphic packages, there are minor deviations from the requirements of regulatory documents. **9-8 points**

"Satisfactory" -- The presentation does not fully and with insufficient clarity reveal the main points. The material is vague, there are grammatical errors. **7-6 points**

"Unsatisfactory" -- Does not meet the criterion "Satisfactory" **0 points.**

9. ***Report quality.*** Weight score – 10

Evaluation criterion with the definition of four levels:

"Excellent"-- The student clearly and fully revealed the purpose of the work, ways to achieve it, deeply argues the decisions made. 1**0 points**

"Good"-- The student clearly and fully disclosed the purpose of the work, ways to achieve it, deeply argues the decisions made, but assumes insignificant errors and inaccuracies. **9-8 points**

"Satisfactory" -- The report on the work done is essentially true, but constructed illogically, vaguely, has many inaccuracies. **7-6 points**

"Unsatisfactory" -- Does not meet the criterion "Satisfactory" **0 points.**

10. ***Ability to lead a scientific discussion.*** Weight score – 10

Evaluation criterion with the definition of four levels:

"Excellent"-- The answers to the questions demonstrate the student's ability to professionally defend his own point of view, as well as the fact that he has professional knowledge at the current level. 1**0 points**

"Good"-- The student can professionally defend his own point of view. The answers to the questions are essentially correct, but not always sufficiently complete and reasoned. **9-8 points**

"Satisfactory" -- The answers to the questions are incomplete, there are significant inaccuracies in the reasoning of decisions. **7-6 points**

"Unsatisfactory" -- Does not meet the criterion "Satisfactory" **0 points.**

Rating scale (R): *Sum of weight points*: ***RS = 10 + 10 + 10 + 10 + 10 + 10 + 10 = 70 points***.

Work protection Rzah = 10 + 10 + 10 = 30 points.

Thus, the rating scale for the defense of the thesis is -- ***RD = RS + Rzah = 70 + 30 = 100 points***

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)

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

10. Appendices to the syllabus of the discipline "Diploma Design"

Appendix 1. Program learning outcomes (extended form)

As a result of studying the discipline ***"Diploma Design"*** 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)**
1.	Plan and perform theoretical research in biomedical engineering and related interdisciplinary areas using modern tools, critically analyze the results of their own research and the results of other researchers in the context of the whole set of modern knowledge on the research problem	Ability to conduct experiments according to specified technical and medical methods, perform computer processing, analysis and synthesis of the results	Ability to implement modern diagnostic and therapeutic methods related to the use of biotechnology, computer and nanotechnology
2.	Apply modern tools and	Ability to search, process	Ability to form and

	technologies for information retrieval, processing and analysis.	and analyze information from various sources.	substantiate medical and technical requirements for medical devices
3	Research, develop, apply, improve and implement solutions, tools and methods of engineering and exact sciences, as well as methods and technologies of medical and bioengineering to solve problems related to human health and quality of life.	Ability to solve complex problems in the field of professional and / or research and innovation activities in the field of biomedical engineering, which involves a deep rethinking of existing and the creation of new holistic knowledge and / or professional practice.	Ability to perform original research, achieve scientific results that create new knowledge in biomedical engineering and related interdisciplinary areas and can be published in leading scientific journals in biomedical engineering, bioengineering, medicine and related fields.
4	Solve the problems of bioengineering for the artificial creation or replacement of cells, tissues and organs of the human body, for the artificial improvement and correction of their functions, the development on this basis of medical and diagnostic technologies, tools and systems.	Ability to work with information: to find, evaluate and use information from various sources, necessary for solving scientific and professional problems	Ability to implement modern diagnostic and therapeutic methods related to the use of biotechnology, computer and nanotechnology
5	Develop and implement and solve significant scientific and technological problems of biomedical engineering in compliance with the norms of academic ethics and taking into account social, economic, environmental and legal aspects.	Ability to substantiate and defend the strategies used, experiments performed and applied methods of engineering and exact sciences to solve problems in biology, medicine, medical and bioengineering	Ability to improve the technical elements of medical devices and systems and medical devices in the process of professional activity
6	Choose basic and auxiliary materials, methods and tools for the implementation of technical projects, apply modern methods and techniques of modeling in the design of medical equipment and medical devices	Ability to review existing concepts of biomedical engineering, bioengineering and healthcare from the standpoint of critical thinking and adaptation of newly created technologies, by generating original hypotheses.	Ability to apply methods and tools for forecasting and modeling to study the behavior and properties of biological systems

[6] Наказ Міністерства освіти і науки України № 1264 від 19.11.2018 року «Про затвердження стандарту вищої освіти за спеціальністю 163 Біомедична інженерія» для третього рівня вищої освіти».

Work program of the discipline "Diploma Design" (syllabus): Compiled *by Associate Professor of Biomedical Engineering,* ***Mykola Bogomolov****.*

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).[1]

[1] Шаблон силабусу погоджено методичною радою університету