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

Department
biomedical engineering

Biomedical devices, apparatus, and complexes.
Analysis and design of electronic 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	*4,5 ECTS credits / 150 hours*
Semester control / Control measures	*Test Work, Modular Test Work, Calculation and Graphic Work*
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 "Analysis and design of electronic medical equipment" (hereinafter ADEME) 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 "Medical Microprocessor Systems" 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 " Analysis and design of electronic medical equipment " belongs to the cycle of professional training and has an interdisciplinary nature. It integrates knowledge from other disciplines according to its subject: analog and digital circuitry, "Measuring transducers and sensors", "Fundamentals of design and engineering of medical equipment in SolidWorks". The discipline "Analysis and design of electronic medical equipment" is basic for such educational components as "Undergraduate practice", "Execution of a bachelor'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 analysis of electronic systems

Subject 1.1. General information on the design and analysis of electronic systems

Subject 1.2. Medical equipment and technology standards.

Subject 1.3. Analysis and design standards for medical equipment and technology

Section 2. Analysis and design of electronic medical technology by CAD PROTEUS and COMSOL

Subject 2.1. Basic features of CAD Proteus and COMSOL for analysis and design of equipment
Subject 2.2. Determination of static and dynamic characteristics of semiconductor devices and chips in the Proteus environment
Subject 2.3. Design of devices for measuring and initial processing of biological signals
Subject 2.4. Design of systems with microprocessors in the Proteus environment
Subject 2.5. Design of devices for measuring temperature, pressure, humidity, speed and acceleration.
Subject 2.6. Electric drive design.
Subject 2.7. Design of systems with ultrasonic devices in the Proteus and COMSOL environments.
Subject 2.8. Design an electronic device using Wi-Fi in the Proteus and COMSOL environments.

Section 3. Design of power supplies for electronic medical equipment
Subject 3.1. Basic requirements for power supplies for medical equipment.
Subject 3.2. Voltage stabilizers based on discrete semiconductor devices and chips
Subject 3.3. Pulse voltage stabilizers.
Subject 3.4. Automated design of pulse voltage stabilizers in PI Expert environment.
Subject 3.5. High frequency power supplies.
Subject 3.2. High voltage power supplies.

Section 4. Design of printed circuit boards and cooling systems for electronic equipment.
Subject 4.1. Purpose, types, and technology of production of printed circuit boards.
Subject 4.2. PCB design in Proteus environment.
Subject 4.3. Dependence of reliability of work of components of electronic equipment on temperature.
Subject 4.4. Types and devices of cooling systems.
Subject 4.5. Thermal physics of cooling processes.
Subject 4.6. Design of cooling systems in Solid Works and Fusion 360 environments

4. Training materials and resources

Basic literature:

1. *Моделювання та аналіз цифрових схем / В. Макаренко, Є. Маланчук, А. Рудик та ін. - Рівне: НУВГП, 2017. - 454 с.*
2. *А. В. Чураков. Принципы моделирования и проектирования приборов магнито ультразвуковой терапии : учеб.-метод. пособие / А. В. Чураков. – Минск : БГУИР, 2019. – 146 с. : ил.*
3. *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.*
4. *Курушин А.А. Решение мультифизических СВЧ задач с помощью САПР COMSOL– М., «One-Book», 2016, 376 стр*

Additional literature:

1. Ляшенко О. Моделювання та дослідження електронних пристроїв: Навч. посібник. / О. Ляшенко, О. Мартинюк. – Луцьк: Східноєвроп. нац. ун-т ім. Лесі Українки, 2013. – 217 с.

2. Лопаткин А.В. Проектирование печатных плат в Altium Designer / А.В. Лопаткин. – М.: DMK Пресс, 2016. – 400 с.

3. Цифрова схемотехніка електронних систем. Підручник / В. Бойко, В. Жуйков, А. Зорі та ін. - К.: Вища школа, 2010. - 426 с.

4. А.В. Бердников, М.В. Семко, Ю.А. Широкова Медицинские приборы, аппараты, системы и комплексы. Часть I. Технические методы и аппараты для экспресс-диагностики: Учебное пособие / Казань: Изд-во Казан. гос. техн. ун-та, 2004. 176 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, 4.5 ECTS credits / 150 hours				
1.	General information on the design and analysis of electronic systems Medical equipment and technology standards. Analysis and design standards for medical equipment and technology	PLO 1 PLO 2 PLO 3	Practical work 1 Laboratory work 1	1rd week
2.	Basic features of CAD Proteus and COMSOL for analysis and design of equipment	PLO 3 PLO 40	Practical work 2	2th week
3.	Determination of static and dynamic characteristics of semiconductor devices and chips in the Proteus environment	PLO 2 PLO 3	Practical work 2	2th week
4.	Design of devices for measuring and initial processing of biological signals	PLO 7	Practical work 2	2th week
5.	Design of systems with microprocessors in the Proteus environment	PLO 8	Practical work 3 Laboratory work 2	3th week
6.	Design of devices for measuring temperature, pressure, humidity, speed and acceleration.	PLO 9	Practical work 3 Laboratory work 2	3th week
7.	Electric drive design.	PLO 10	Practical work 3 Laboratory work 2	3th week
8.	Design of systems with ultrasonic devices in the Proteus and COMSOL environments.	PLO 31	Practical work 4	4th week
9.	Design an electronic device using Wi-Fi in the Proteus and COMSOL environments.	PLO 40	Practical work 4	4th week
10.	Basic requirements for power supplies for medical equipment.	PLO 5	Practical work 5 Laboratory work 3	5th week

11.	Voltage stabilizers based on discrete semiconductor devices and chips	PLO 36	Practical work 5 Laboratory work 3	5th week
12.	Pulse voltage stabilizers.	PLO 9	Practical work 5 Laboratory work 3	5th week
13.	Automated design of pulse voltage stabilizers in PI Expert environment.	PLO 8	Practical work 6	6th week
14.	High frequency power supplies.	PLO 36	Practical work 6	6th week
15.	High voltage power supplies.	PLO 36	Practical work 6	6th week
16.	Purpose, types and technology of production of printed circuit boards.	PLO 8	Practical work 7 Laboratory work 4	7th week
17.	Purpose, types and technology of production of printed circuit boards.	PLO 8	Practical work 7 Laboratory work 4	7th week
18.	Dependence of reliability of work of components of electronic equipment on temperature.	PLO 40	Practical work 7 Laboratory work 4	7th week
19.	Types and devices of cooling systems.	PLO 10	Practical work 7 Laboratory work 4	7th week
20.	Thermal physics of cooling processes.	PLO 19	Practical work 7 Laboratory work 4	7th week
21.	Design of cooling systems in Solid Works and Fusion 360 environments	PLO 31	Practical work 7 Laboratory work 4	7th week
22.	Calculation and graphic work	PLO 1 PLO 4 PLO 6 PLO 13	Registration and submission of work	8th week
23.	Modular control work	PLO 10-19		8th week
24.	Test			9th week

6. Independent student work

One of the main types of semester control during the mastering of the discipline " Analysis and design of electronic 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.

Approximate subject of calculation and graphic work:

1. *Design of a d'Arsonval apparatus;*
2. *Design of pyrometer;*
3. *Designing a magnetotherapy device;*
4. *Design of an electrophoresis device;*
5. *Design of a device for automatic blood pressure measurement;*
6. *Designing a pulsed current treatment device;*
7. *Design of a portable electrocardiograph;*
8. *Design of a hearing aid device;*
9. *Design of a laser therapy machine;*
10. *Design of a breathing simulator;*
11. *Design of a power wheelchair;*
12. *Design of a device for electrocautery;*
13. *Design of a color therapy apparatus;*
14. *Design of an Ultrasonic toothbrush.*

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):

1. *Autumn semester, 4.5 ECTS credits / 135 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	32
3.	Execution and test of laboratory works	27	3	9	27
4.	Modular control work (MCW)	12	12	1	12
5.	Calculation and graphic work (CGW)	15	15	1	15
6.	Test work[1]	80	80	1	80
	Total				100

2. *Spring semester, 4.5 ECTS credits / 135 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	32

[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.*

3.	Execution and test of laboratory works	27	3	9	27
4.	Modular control work (MCW)	12	12	1	12
5.	Calculation and graphic work (CGW)	15	15	1	15
6.	Test work[2]	80	80	1	80
	Total				100

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

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

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

If the grade for the test is lower than the rating, a "hard" RSE is used - the previous rating of the applicant (except for points for the semester individual task) is canceled and he receives a grade based on the results of the test. This option forms a responsible attitude of the applicant to the decision to perform the test, forces him to critically assess the level of his training and carefully prepare for the test.

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

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

Criterion			The CC
Deadline of calendar controls			8th week
Conditions for obtaining a positive result from the calendar control	Current rating		≥ 24 points
	Execution practical work	PW № 1- 8	+
		PW № 9-16	-
	Execution of laboratory 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	-
	Calculation and graphic work	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
3	All laboratory works are tested	More than 14 points
4	Writing at least 6 express tests / tests	More than 6 points

[2] *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.*

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, Shlykov Vladyslav Valentynovych, Head of the Department of Biomedical Engineering.*

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

" Analysis and design of electronic medical equipment "

The list of questions for preparation for modular control work,

And also for preparation for test

1. *General information on the design and analysis of electronic systems.*
2. *Medical equipment and technology standards.*
3. *Analysis and design standards for medical equipment and technology.*
4. *Basic features of CAD Proteus and COMSOL for analysis and design of equipment.*
5. *Determination of static and dynamic characteristics of semiconductor devices and chips in the Proteus environment.*
6. *Design of devices for measuring and initial processing of biological signals.*
7. *Design of systems with microprocessors in the Proteus environment.*
8. *Design of devices for measuring temperature, pressure, humidity, speed, and acceleration.*
9. *Electric drive design.*
10. *Design of systems with ultrasonic devices in the Proteus and COMSOL environments.*
11. *Design an electronic device using Wi-Fi in the Proteus and COMSOL environments.*
12. *Basic requirements for power supplies for medical equipment.*
13. *Voltage stabilizers based on discrete semiconductor devices and chips.*
14. *Pulse voltage stabilizers.*
15. *High voltage power supplies.*
16. *Purpose, types and technology of production of printed circuit boards.*
17. *PCB design in Proteus environment.*
18. *Dependence of reliability of work of components of electronic equipment on temperature.*
19. *Types and devices of cooling systems.*
20. *Thermal physics of cooling processes.*
21. *Design of cooling systems in Solid Works and Fusion 360 environments.*