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

Department
biomedical engineering

Analog and Digital Circuitry.
Part 2. Digital Circuitry
Working program of basic discipline (Silabus)

Requisites for basic discipline	
Level of higher education	***First (bachelor's)***
Branch of knowledge	*16 Chemical engineering 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	*3th course, autumn semester*
The scope of discipline	*5 ECTS credits / 150 hours*
Semester control / Control measures	*Exam, Modular Test 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, Associate Professor, Professor Departmen of BME Ivanets Olga, e-mail: olchik2104@ukr.net,* ***Practical:*** *Doctor of Technical Sciences, Associate Professor, Professor Department of BME Ivanets Olga, e-mail: olchik2104@ukr.net*
Course placement	*Platform «Sikorsky» - course «Digital Circuitry» (dx36it)*

Distribution of hours

Semester	Lectures	Practical	Laboratory	Independent Work
spting semester	*32*	*32*	*16*	*70*

Curriculum of the discipline

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

The main purpose of the discipline "Digital Circuitry" is to form students' ability to solve complex specialized problems and practical problems of architecture of logical components as part of microcircuits and using discrete elements, which involves the use of theories and scientific methods of analog and digital electronics, software and hardware for medical devices and systems.

The discipline "Digital Circuitry" studies the application of methods analyze the analog and digital electronics, architecture of digital logic devices and microcircuits for the design of medical devices and systems to solve problems related to the development and engineering of biological and medical devices and systems that include digital microcircuits.

Skills are required to study the discipline:

1. Knowledge of a foreign language;
2. Fundamentals of computer science regarding the organization of numerical calculation methods;
3. General methods for building digital systems;
4. Technological bases of digital technology;
5. Analysis and synthesis of digital circuits of combinational and sequential type;

6. Construction of functional units of digital diagnostic and physiotherapeutic devices.
7. Methods for designing digital device-based medical systems.

General competencies *(OPP was put into effect by the Rector's Order NON/434/2024 of 10.06.2024 p.):*

ZK 1 - *Ability to apply knowledge in practical situations.*
ZK 2 *- Knowledge and understanding of the subject area and understanding of professional activities.*
ZK 5 *- Ability to conduct research at an appropriate level.*
ZK 6 *- Ability to search, process, and analyze information from various sources.*
ZK 8 *- Ability to make informed decisions.*

Special (professional) competencies *(OPP was put into effect by the Rector's Order NON/434/2024 of 10.06.2024 p.):*

FK 2 *- Ability to provide engineering and technical expertise in the planning, development, evaluation, and specification of medical equipment.*
FK 6 *- Ability to effectively use tools and methods for analysis, design, calculation, and testing in the development of biomedical products and services.*
FK 12 *- Ability to ensure and monitor compliance with safety and biomedical ethics when working with medical equipment.*

The programs learning outcomes after studying the discipline "Digital Circuitry" are *(OPP was put into effect by the Rector's Order NON/434/2024 of 10.06.2024 p.):*

PRN 1 *- The ability to apply knowledge of the fundamentals of mathematics, physics and biophysics, bioengineering, chemistry, engineering graphics, mechanics, materials resistance and strength, properties of gases and liquids, electronics, computer science, signal and image acquisition and analysis, automatic control, system analysis, and decision-making methods at a level necessary for solving biomedical engineering tasks.*
PRN 2 - *Formulate logical conclusions and reasoned recommendations regarding the assessment, operation, and implementation of biotechnical, medical-technical, and bioengineering tools and methods.*
PRN 7 *- Provide engineering support, service, and technical maintenance during the operation of laboratory analytical equipment, medical diagnostic and therapeutic complexes and systems in accordance with the rules established by technical documentation and regulatory documents governing the procedures for commissioning, application, and repair of medical equipment, as well as to form the standard documentation by types of work according to the technical regulation on medical devices.*
PRN 8 *- Understand theoretical and practical approaches to the creation and management of medical equipment and medical technology.*

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

The discipline "Digital Circuitry" belongs to the cycle of professional training and has an interdisciplinary nature. It integrates according to its subject knowledge from other disciplines: analog circuitry, fundamentals of electrical engineering, physics and more. According to the structural and logical scheme of the training program, the discipline "Digital Circuitry" is closely related to other disciplines of general and professional training: "Fundamentals of Electrical Engineering", "Analog Circuitry", "Biomedical Devices, Apparatus and Complexes ", "Microprocessor Engineering", Introductory Practice in Medical Engineering. It is immediately preceded by the discipline "Analog Circuitry".

The acquired practical skills and acquired theoretical knowledge during the study of the discipline "Digital Circuitry " can be used in the future during the acquisition of academic disciplines:

- from the cycle of professional training (educational-professional program "Medical Engineering"): " Microprocessor Engineering";

- from elective disciplines (educational-professional program "Medical Engineering"): "Medical Equipment", "Development and operation of physiotherapeutic medical devices", " Information support for diagnostic and treatment processes of patients with lost limbs", "Design of medical information systems".

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 provisions for the construction of logic components.

Subject 1.1. Analysis of digital and analogy signals.

Subject 1.2. Basic logic components on discrete elements.

Section 2. The integrated logic elements.

Subject 2.1. Analysis of logic elements in microcircuits.

Subject 2.2. Encoder and decoder. Analysis of microcircuits 74HC148 and 74HC138.

Subject 2.3. Multiplexer. Analysis of the circuit connection diagram and the operation of the microcircuit74HC151.

Subject 2.4. Demultiplexer. Analysis of the circuit connection diagram and the operation of the microcircuit74HC238.

Section 3. Digital devices for storing and transmitting information in biomedical systems

Subject 3.1. Adder. Half-adder. Full single-bit adder.

Subject 3.2. Digital comparator. Single-bit digital comparator. Digital four-bit comparator.

Subject 3.3. Trigger. RS trigger. D trigger.

Subject 3.4. Counters. Binary, binary-decimal counters. Counters with arbitrary reference modulus..

Section 4. Practical implementation of digital devices.

Subject 4.1. Design of a rectangular pulse generator.

Subject 4.2. Design of a light sensor.

Subject 4.3. Touch sensor design. Design of a touch sensor with humidity level.

Subject 4.4. Design of an adder.

Section 5. Practical application of microcircuits.

Subject 5.1. Design of an electromagnetic field detector using the LM 386 microcircuit.

Subject 5.2. Comparative analysis of various connection schemes for forming opposing sensors based on the LM324 microcircuit.

Subject 5.3. Design of a sound amplifier using digital elements.

4. Training materials and resources

Basic literature:

1. *Цифрова схемотехніка та архітектура мікропроцесорів : навчальний посібник / С. П. Євсеєв, Н. В. Дженюк, М. Ю. Охрименко та ін. Харків : НТУ «ХПІ» ; Львів : «Новий Світ-2000», 2025. –513 с. ISBN 978-966-418-396-0*
2. *Минайленко, Р. М. Конопліцька-Слободенюк О. К. Цифрова схемотехніка : навч. посіб. М-во освіти і науки України, Центральноукраїн. нац. техн. ун-ті. 3-є вид., допов. Кропивницький : Лисенко В. Ф., 2024. 118 с. https://dspace.kntu.kr.ua/server/api/core/bitstreams/605ed62b-1398-4c0b-919e-35f11f0a2b68/content*

3. *Конспект лекцій з дисципліни "Цифрова схемотехніка" для здобувачів вищої освіти першого (бакалаврського) рівня зі спеціальностей 171 «Електроніка» та 153 «Мікро- та наносистемна техніка»; / Багрій В.В. , Кам'янське; ДДТУ, 2019 - 238 с https://www.dstu.dp.ua/Portal/Data/3/22/3-22-kl38.pdf*
4. *Рябенький В.М. Жуйков В.Я. Ямненко Ю.С. Заграничний А.В. Схемотехніка: Пристрої цифрової електроніки ТОМ 1 Рекомендовано Методичною радою НТУУ «КПІ» як електронний підручник для студентів, що навчаються за спеціальністю «Електроніка» Київ 2016. 399с.*
5. *Louis E. Frenzel. Principles of Electronic Communication Systems: 5 th. Edition, McGraw Hill, 2022.*
6. *Бабич Н.П., Жуков И.А. Компьютерная схемотехника- К.: «МК-Пресс», 2004 г.*
7. *Рябенький В.М., Жуйков В.Я., Гулий В.Д. Цифрова схемотехніка: Навч. посібник. - Львів: «Новий Світ-2000», 2009.-736 с.*

Additional literature:

1. *Білинський Й. Й., Книш Б. П. ЦИФРОВА СХЕМОТЕХНІКА Електронно-обчислювальні пристрої Навчальний посібник Вінниця ВНТУ 2021. 66с.*
2. *Цифрова схемотехніка. Навчальний посібник./ М.Г. Лорія, П.Й. Єлісєєв, О.Б. Целіщев. – Сєвєродонецьк: Вид-во Східноукр. нац. ун-ту імені Володимира Даля, 2016. – 280 с., 112 іл., 9 табл., 30 бібліогр. назв.*
3. *https://dspace.snu.edu.ua/server/api/core/bitstreams/6e572b3f-3c7e-4c5a-a21f-6c6efa85fadd/content*
4. *https://org2.knuba.edu.ua/pluginfile.php/11275/mod_resource/content/0/Herris_Devid_M._Cifrovaya_shemotehnika_i_arhitektura_komputera._Vtoroe_izdanie_Litmir.net_bid253345_original_12239.pdf.*
5. *Зубчук В.І., Захарчук Н.В. «Цифрова схемотехніка» [Електронний ресурс]: практикум з дисципліни «Електроніка» для студентів спеціальностей 6.051402 -«Біомедична інженерія», та 6.051003 «Приладобудування» НТУУ «КПІ» , 2016. – 194 с. – Назва з екрана. – Доступ: http://ela.kpi.ua/handle/123456789/19696.*
6. *Зубчук В.І., Делавар-Касмаі М. Цифрова схемотехніка. Конспект лекцій до вивчення кредитного модуля «Цифрова схемотехніка» [Електронний ресурс]: навчальний посібник для студентів, які навчаються за спеціальностю 163 - Біомедична інженерія, спеціалізацією «Клінічна інженрія». НТУУ «КПІ ім. Ігоря Сікорського» , 2019. – 184 с. – Назва з екрана. – Доступ: http://ela.kpi.ua/handle/ 123456789/27856.*
7. *https://www.youtube.com/watch?v=Mh-oLiEd9s4&list=PL4WQQHlheqfy7oOk8AzanWi9jJ3f90_jx&index=3*
8. *https://www.youtube.com/watch?v=QbECw8RwGwk&list=PL4WQQHlheqfzl71QHEBzrB_dRLF1fI7wz&index=25*
9. *https://openarchive.nure.ua/server/api/core/bitstreams/835aaa1f-9703-47c1-a5ac-4613a7235a99/content*
10. *Digital Design and Computer Architecture by David Money Harris and Sarah L Harris ELSEVIER INC., 360 Park Avenue South, New York, NY 10010, USA Morgan Kaufman © English Edition ISBN 978-0-12-394424-5.*

Educational content

5. Methods of mastering the discipline (educational component)

№ s/n	Subject	Program learning outcomes	The main tasks	
			Control measure	Deadline
1.	Analysis of digital and analogy signals Part 1. Comparative analysis of analog and digital signals. Characteristics of a digital signal; Part 2. Basic number systems.	PRN 7 PRN 8	Practical work 1 Laboratory work 1	1-2nd week тиждень
2.	Basic logic components on discrete elements: Part 1. Comparative analysis of OR logic element circuits using diodes and transistors. Part 2. Comparative analysis of AND logic element circuits using diodes and transistors.	PRN 7	Practical work 2	3rd week
3.	Logic components. Hardware Description Language: Part 1. Comparative analysis of NOT, NAND, and NOR logic element circuits using transistors; Part 2. Digital circuit description languages.	PRN 7 PRN 8	Practical work 3 Laboratory work 2	4th week
4.	Practical use of logic elements in microcircuits: Part 1. Logic elements in 74NS08 and 74NS00 microcircuits. Comparative analysis of electrical circuits using AND and OR logic elements. Part 2. Logic elements in 74NS00 and 74NS02 microcircuits. Comparative analysis of electrical circuits using NAND and NOR logic elements;	PRN 7 PRN 8	Practical work 4	5th week
5.	Multiplexers and demultiplexers: Part 1. Connection diagrams of 74HC151 and 74HC238 microcircuits. Truth table of 74HC151. Results of the multiplexer operation; Part 2. Logic levels of a digital signal	PRN 1 PRN 8	Practical work 5 Laboratory work 3	6-7th week
6.	Encoders and Decoders: Part 1. Encoders. Connection diagrams for the 74NS148 microchip. Study of the truth table for the 74NS148 encoder. Practical study of the encoder's operation. Part 2. Decoders. Connection diagrams for the 74NS238 microchip. Practical study of the decoder's operation.	PRN 1 PRN 2	Practical work 6	8th week
7.	Arithmetic devices: Part 1: Half adders. Full adders.	PRN 1 PRN 2	Practical work 7 Laboratory	9th week

№ s/n	Subject	Program learning outcomes	The main tasks	
			Control measure	Deadline
	Part 2. Multi-input adder		work 4	
8.	Digital comparators: Part 1. Truth table of the comparator 74HC85; Part 2. Analysis of the circuit of a digital four-bit comparator.	PRN 2 PRN 7	Practical work 8	10th week
9.	Triggers. RS-trigger: Part 1. Truth tables of RS-trigger and synchronous RS-trigger. Types of RS-triggers (D-, T-, JK-triggers): comparative analysis of truth tables. Part 2. RS-trigger on NOR elements. Study of the operation of the electrical circuit. D-trigger. Connection diagram using the chip74HC74.	PRN 2 PRN 4	Practical work 9	12th week
9.	Counters: Part 1. Binary, binary-decimal counters.; Part 2. Counters with arbitrary reference modulus.	PRN 8	Practical work 10	12th week
10.	Creating integrated circuit topologies in GDS II format.	PRN 1	Laboratory work 5	
11.	Practical implementation of digital devices. Part 1. Design of a rectangular pulse generator Part 2. Recommendations for organizing the digital devices of medical and bioengineering devices.	PRN 2 PRN 8	Practical work 11	12th week
12.	Noise level calculation: Part 1. Permissible noise levels; Part 2. Logic levels and noise levels.	PRN 2 PRN 7	Laboratory work 6,7	13th week
13.	Touch sensor design: Part 1. Design of a touch sensor with humidity level; Part 2. Using a touch sensor the functioning of biological objects and electrical processes in the body.	PRN 2 PRN 8	Practical work 12	
6.	Analysis of the principle of operation of an operational amplifier in an electromagnetic field detector circuit: Part 1. Conducting experimental studies of the presence of an electromagnetic field under various conditions of influence. Part 2. Recommendations for organizing medical and bioengineering devices	PRN 2 PRN 8	Practical work 13	13th week
13.	Truth table for a seven-segment indicator decoder.	PRN 7	Laboratory work 8	14th week
14.	Practical implementation of digital	PRN 8	Practical work 14	

№ s/n	Subject	Program learning outcomes	The main tasks	
			Control measure	Deadline
	devices: Part 1. Analysis of the principle of operation of an operational amplifier as an analogy comparator.; Part 2. Comparative analysis of various connection schemes for forming opposing sensors.			
15.	Practical implementation of digital devices: Part 1. Design of a sound amplifier using digital elements; Part 2. Conducting experimental research.	PRN 1	Practical work 15	15th week
16.	Modular control work		Practical work 16	

Practical works

The main tasks of the cycle of practical works: consolidation in practice of the main provisions of the academic discipline "Digital Circuitry" by performing specially formulated tasks and real circuit-technical variants of biomedical equipment units, which are actually designed in the master's theses of students. The practical class includes conducting a control of knowledge, skills and abilities, solving problems of designing digital device with their discussion, solving control tasks, their verification and evaluation.

The grades received by the student for individual practical classes are entered into the journal of the study group and are taken into account when determining the final grade (rating) for this academic discipline.

№ s/n	Practical work topic	Duration in hours
1	Digital signal	4
2	Basic logic component OR, AND	4
	Basic logic component NOR, HAND, NOT	
3	Logic elements in 74NS08 and 74NS00 microcircuits	4
4	Multiplexers and demultiplexers	4
	Encoder and decoder	
5	Arithmetic devices	4
	Counter	
6	Trigger	4
	Comparator	
7	Practical implementation of digital devices. Design of a touch sensor	4
8	Design of electromagnetic field detector	4
8	Design of a rectangular pulse generator	2
9	Module test work	2
Total hours		36

Laboratory works

The main tasks of the laboratory work cycle: consolidation in practice of the main provisions of the academic discipline "Digital Circuits" by performing specially formulated tasks that allow using in practical implementation the main requirements for circuit design solutions, in particular biomedical equipment components, which are actually developed in the students' master's theses. Practical work includes conducting a control of knowledge, skills and abilities, solving problems of designing digital Circuits with their discussion, solving control tasks, their verification and evaluation.

The grades received by the student for individual laboratory work are entered into the journal of the study group and are taken into account when determining the final grade (rating) for this academic discipline.

№ s/n	*Practical work topic*	*Duration in hours*
1	*Basic number systems*	*2*
2	*Digital circuit description languages*	*2*
3	*Logic levels of a digital signal*	*2*
4	*Multi-input adder*	*2*
5	*Creating integrated circuit topologies in GDS II format*	*2*
6	*Permissible noise levels*	*2*
7	*Logic levels and noise levels*	*2*
8	*Truth table for a seven-segment indicator decoder.*	*2*
Total hours		*16*

6. Independent student work

Types of independent work *(preparation for classroom lessons, calculations based on primary data obtained in laboratory classes, solving problems, writing an essay, performing calculation work, completing homework, etc.):*

№ s/n	Types of work submitted for independent work	Duration in hours IW
1	*Review of lecture material and study of questions assigned for independent work*	10
2	*Preparation for practical works*	28
3	*Preparation for laboratory works*	18
4	*Preparation for modular control work*	4
5	*Preparation for the Exam*	30
Total hours		90

Distribution of hours of independent work of students by educational content topics:

№ s/n	Titles of topics and questions to be studied independently and references to educational literature	Duration in hours IW
1	*Properties of an electrical impulse.* *The list of issues submitted for independent study: compare an analogy and*	5

№ s/n	Titles of topics and questions to be studied independently and references to educational literature	Duration in hours IW
	digital signal, characterize a digital signal. Describe the features of a positive and negative pulse, describe the properties of an electrical pulse (positive, negative) [1, 2, 5, 10].	
2	*The features of the influence of noise on signal.* *List of questions submitted for independent study: describe the principles of calculating the noise limit, give examples, describe the advantages and disadvantages of a digital and an analogy signal for biomedical tasks, describe the features of the influence of noise on an analogy or digital signal [2, 7].*	2
3	*The basic logical functions.* *List of questions submitted for independent study: provide characteristics of basic logical functions, describe existing types of gates [1, 2].*	2
4	*The logical elements AND, OR, HAND, NOR.* *List of issues submitted for independent study: Describe logical elements AND, OR, HAND, NOR give truth tables, conduct a comparative analysis of the electrical circuits of the AND, OR, HAND, NOR logic element in discrete components and as part of the chip [1, 2,7].*	5
5	*The logical elements NOT, NE, XOR, XNOR.* *List of issues submitted for independent study: describe the logical elements NOT, NE, XOR, XNOR, give truth tables [1, 2,7].*	5
6	*The encoder and decoder.* *The list of issues that are submitted for independent study: describe the functions of an encoder, describe the functions of a decoder [2, 4].*	4
7	*The multiplexer and demultiplexer.* *The list of issues submitted for independent processing: Describe the functions of a multiplexer, describe the functions of a demultiplexer [2,3].*	4
8	*The adder.* *The list of questions submitted for independent study: describe the functions of a full adder, describe the functions of a half adder, conduct a comparative analysis of a half adder and a full adder [3, 5].*	4
9	*A digital comparator.* *The list of questions submitted for independent study: describe the functions of a digital comparator, provide a detailed block diagram of a digital comparator on logic circuits [3, 4].*	4
10	*RS flip-flop.* *List of questions submitted for independent study: Describe the functions of an RS flip-flop, provide a truth table of an RS flip-flop and a synchronous RS flip-flop [4, 5].*	5
11	*A flip-flop.* *List of questions submitted for independent study: describe the functions of a D flip-flop, T flip-flop, JK flip-flop, provide a truth table of a D flip-flop, T flip-flop, JK flip-flop [3, 4].*	4
12	*The counter.* *List of questions submitted for independent study: describe the purpose of counters, provide their classification [1, 6].*	4
13	*A multivibrator.*	2

№ s/n	Titles of topics and questions to be studied independently and references to educational literature	Duration in hours IW
	List of issues submitted for independent study: describe the purpose of a multivibrator, provide a diagram [5, 6].	
14	*Arithmetic devices.* *List of issues submitted for independent study: half adders, full adders, multi-input adder [1, 6].*	4
15	*Circuits of multivibrator.* *List of questions submitted for independent study: conduct a comparative analysis of multivibrator circuits on transistors and the chip [5, 6].*	2
16	*Modular test work*	4
17	*Exam*	30
Total hours		90

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 for the practical implementation of assembling real circuits on a breadboard using real components, 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 are not fulfilled.

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*	
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 "Digital Circuit" 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 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):

№ s/n	Control measure	%	Weight points	Number	Total
1.	Simulation of practical work tasks with a report	10	2	5	10
2.	Execution and test of practical works	45	3	15	45
3.	Execution and test of laboratory works	24	3	8	24
4.	Modular control work (MCW)	15	15	1	15
5.	Presentation of laboratory works	6	15	1	6
	Total				100

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 first CC	The second CC
Deadline of calendar controls			8th week	14th week
Conditions for obtaining a positive result from the calendar control	Current rating		≥ 24 points	≥ 42 points
	Execution practical work	PW № 1- 7	+	+
		PW № 7-15	-	+
	Execution of laboratory works	LW № 1- 4	+	+
		LW № 5- 8	-	+
	Express control works / test tasks	At least 4 of any lectures	+	-
		At least 8 of any lectures	-	+
	Modular control work	Estimated MCW	-	+

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 presentation of laboratory works	More than 3 points
3	All practical works are tested	More than 19 points
3	All laboratory works are tested	More than 14 points
4	Simulation of practical work tasks with a report	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:

[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.*

Number points	Assessment on the university scale
100-95	Perfectly
94-85	Very good
84-75	Good
74-65	Satisfactorily
64-60	Enough
Less 60	Unsatisfactorily
Admission conditions are not met	Not allowed

9. Additional information on the discipline (educational component)

Appendix 1. Program learning outcomes (extended form)

In accordance with the Order of the Ministry of Education and Science of Ukraine No. 1204 dated November 19, 2018 "On approval of the standard of higher education in the specialty 163 Biomedical Engineering" for the first bachelor's level of higher education", in Appendix 1 establishes the correspondence of learning outcomes to competencies in the discipline "Digital Circuit".

Appendix 2. The list of questions for preparation for module control work

The list of questions for preparation for modular control work, and also for preparation for credit is given in Appendix 2.

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, Ivanets Olga Borysovna, Professor of the Department of Biomedical Engineering.*

Approved by *the Department of Biomedical Engineering (protocol № 16 of June 21, 2024)*

Approved by *the Methodical Commission of the Faculty of Biomedical Engineering (protocol № 9 of June 26, 2024)*

Appendix 1.

For syllabus of the discipline "Digital Circuits"

Program learning outcomes (extended form)

As a result of studying the academic discipline "Digital Circuit", students will be able to:

Learning outcomes (PRN)		Compliance of Learning Outcomes with Competencies according to the Higher Education Standard [6]	
		General Competencies (**soft skills**)	Special Competencies (**professional**)
PRN 1	*The ability to apply knowledge of the fundamentals of mathematics, physics and biophysics, bioengineering, chemistry, engineering graphics, mechanics, materials resistance and strength, properties of gases and liquids, electronics, computer science, signal and image acquisition and analysis, automatic control, system analysis, and decision-making methods at a level necessary for solving biomedical engineering tasks.*	*ZK 1 - Ability to apply knowledge in practical situations..* *ZK 6 - Ability to search, process, and analyze information from various sources.*	*FK 12 - Ability to ensure and monitor compliance with safety and biomedical ethics when working with medical equipment.*
PRN 2	*Formulate logical conclusions and reasoned recommendations regarding the assessment, operation, and implementation of biotechnical, medical-technical, and bioengineering tools and methods.*	*ZK 1 - Ability to apply knowledge in practical situations.* *ZK 2 - Knowledge and understanding of the subject area and understanding of professional activities.*	*FK 2 - Ability to provide engineering and technical expertise in the planning, development, evaluation, and specification of medical equipment.* *FK 12 - Ability to ensure and monitor compliance with safety and biomedical ethics when working with medical equipment.*
PRN 7	*Provide engineering support, service, and technical maintenance during the operation of laboratory analytical equipment, medical diagnostic and therapeutic complexes and systems in accordance with the rules established by technical documentation and regulatory documents governing the procedures for commissioning, application, and repair of medical equipment, as well as to form the standard documentation by types of work according to the technical*	*ZK 2 - Knowledge and understanding of the subject area and understanding of professional activities.*	*FK 2 - Ability to provide engineering and technical expertise in the planning, development, evaluation, and specification of medical equipment.* *FK 12 - Ability to ensure and monitor compliance with safety and biomedical ethics when working with medical equipment.*

Learning outcomes (PRN)		Compliance of Learning Outcomes with Competencies according to the Higher Education Standard [6]	
		General Competencies (**soft skills**)	Special Competencies (**professional**)
	regulation on medical devices.		
PRN 8	*PRN 8 - Understand theoretical and practical approaches to the creation and management of medical equipment and medical technology.*	*ZK 5 - Ability to conduct research at an appropriate level.* *ZK 6 - Ability to search, process, and analyze information from various sources.* *ZK 8 - Ability to make informed decisions.*	*FK 6 - Ability to effectively use tools and methods for analysis, design, calculation, and testing in the development of biomedical products and services.*

[6] Order of the Ministry of Education and Science of Ukraine No. 1204 dated November 19, 2018 "On approval of the standard of higher education in the specialty 163 Biomedical Engineering" for the first bachelor's level of higher education".

Appendix 2.

For syllabus of the discipline "Digital Circuit"

The list of questions for preparation for module control work,

And also for preparation for test

1. Compare an analogy and digital signal.
2. Characterize a digital signal. Describe the features of a positive and negative pulse.
3 Describe the properties of an electrical pulse (positive, negative).
4. Describe the principles of calculating the noise limit, give examples.
5. Describe the advantages and disadvantages of a digital signal for biomedical tasks.
6. Describe the advantages and disadvantages of an analogy signal for biomedical tasks.
7. Describe the properties of an electrical pulse (positive, negative).
8. Describe the features of the influence of noise on an analogy or digital signal.
9. Describe existing number systems, give examples.
10. Describe the use of analogy and digital signals in biomedical engineering.
11. Provide characteristics of basic logical functions.
12. Describe the features of the influence of interference on a signal from a biological object.
13. Describe the principles by which signal states are determined in basic logic elements.
14. Describe existing types of gates.
15. Describe the function of truth tables, give examples.
16. Describe logical elements AND, OR, HAND, NOR give truth tables.
17. Describe the principles of conjunction disjunction.
18. Describe the logical elements NOT, NE, XOR, XNOR, give truth tables.
19. Describe the principles of operation of the electrical circuit of the logical element AND on diodes.
20. Describe the principles of operation of the electrical circuit of the logical element AND on transistors.
21. Describe the principles of operation of the electrical circuit of the logical element OR on diodes.
22. Describe the principles of operation of the electrical circuit of the logical element OR using transistors.
23. Describe the circuit of the logic element HAND using transistors.
24. Describe the principles of operation of a NOR circuit using transistors.
25. Describe the principles of operation of the NOR circuit using transistors.
26. Describe the logic elements of the 74HC00 chip and describe the inputs and outputs, as well as provide a truth table and an electrical diagram.
27. Describe the logic elements of the DM 74AL S 21A chip and describe the inputs and outputs, as well as provide a truth table and an electrical diagram.
28. Describe the logic elements of the 74HC32 chip and describe the inputs and outputs, as well as provide a truth table and an electrical diagram.
29. Describe the electrical schematic diagram of an integrated organic element using the 74HC08 chip, describe it.
30. Describe the electrical schematic diagram of an integrated organic element using the 74HC32 chip, describe it.
31. Describe the logic elements of the 74HC02 chip and describe the inputs and outputs, as well as provide a truth table and an electrical diagram.

32. Describe the electrical schematic diagram integrated organic element using the 74HC00 chip, describe it.
33. Give an electrical schematic diagram of an integrated organic element using the 74HC02 chip, describe it.
34. Conduct a comparative analysis of the electrical circuits of the NOR logic element in discrete components and as part of the chip.
35. Conduct a comparative analysis of the electrical circuits of the NAND logic element in discrete components and as part of the chip.
36. Conduct a comparative analysis of the electrical circuits of the OR logic element in discrete components and as part of the chip
37. Conduct a comparative analysis of the electrical circuits of the AND logic element in discrete components and as part of the chip.
38. Describe combinational logic devices.
39. Describe sequential logic devices.
40. Describe the functions of an encoder, provide a detailed block diagram of an encoder on logic diagrams.
41. Describe the functions of a decoder, provide a detailed block diagram of an decoder on logic diagrams.
42. Describe the truth table of an encoder and the connection diagram of the corresponding microcircuit, describe the principle of operation.
43. Describe the truth table of an decoder and the connection diagram of the corresponding microcircuit, describe the principle of operation.
44. Describe the functions of a multiplexer, provide a detailed block diagram of an multiplexer on logic circuits.
45. Describe the functions of a demultiplexer, provide a detailed block diagram of a demultiplexer on logic circuits.
46. Describe the functions of a full adder, provide a detailed block diagram of a full adder on logic circuits.
47. Describe the functions of a half adder, provide a detailed block diagram of a half adder on logic circuits.
48. Conduct a comparative analysis of a half adder and a full adder.
49. Describe the functions of a digital comparator, provide a detailed block diagram of a digital comparator on logic circuits.
50. Describe the functions of an RS flip-flop, provide a truth table of an RS flip-flop and a synchronous RS flip-flop.
51. Describe the functions of a D flip-flop, T flip-flop, JK flip-flop, provide a truth table of a D flip-flop, T flip-flop, JK flip-flop.
52. Describe the principles of operation of a D flip-flop circuit on a 74HC74 chip
53. Describe the principles of operation of a synchronous D flip-flop circuit.
54. Describe the procedure for recording and displaying data at the output in a 74HC574 chip.
55. Describe the purpose of counters, provide their classification.
56. Describe the principle of operation of a counter circuit
57. Describe the purpose of a multivibrator, provide a diagram
58. Conduct a comparative analysis of multivibrator circuits on transistors and the LM 324 chip.
59. Conduct a comparative analysis logical elements AND, OR, NOT give truth tables.
60. Conduct a comparative analysis the logical elements NE, XOR, XNOR, give truth tables