Ministry of Education and Science of Ukraine
Dnipro university of technology

Department of Electric Drive

«APPROVED»
Head of the Department of Electric Drive
Khudolii S.S. _____
«30» August 2022

WORK PROGRAM OF THE ACADEMIC DISCIPLINE
«Electronics, microprocessor technology and automation tools»

Field of study	14 Electrical engineering
Specialty	141 Electrical energetics, electrical engineering and electromechanics
Academic level	first (bachelor)
Academic program	«Electrical energetics, electrical engineering and electromechanics»
Specialization.....	-
Status	normative
Total workload	12 credits ECTS (360 hours)
Type of summative assessment ...	differentiated test
Period of study.....	3, 4 semesters (5-8 terms)
Language of study.....	English

Lecturers: Assoc. Prof. Beshta O.O., Assoc. Prof. Yalanskyi O.A.

Prolonged: for: 20__/20__ a.y. _____(_____) «__»___ 20__.
(sign, name, data)

for 20__/20__ a.y. _____(_____) «__»___ 20__.
(sign, name, data)

Dnipro
DNIPROTECH
2022

Work program of the academic discipline «Electronics, microprocessor technology and automation tools» for bachelors of the educational and professional program «Electrical energetics, electrical engineering and electromechanics» of the specialty 141 Electrical energetics, electrical engineering and electromechanics / Dnipro University of Technology, Department of Electric Drive. – D.: DNIPROTECH, 2022 – 17p.

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The work program regulates:
- the aim of the discipline;
- the disciplinary learning outcomes generated through the transformation of the intended learning outcomes of the degree program;
- basic disciplines;
- volume and distribution by forms of organization of the educational process and types of classes;
- discipline program (thematic plan by type of training);
- algorithm for assessing the level of achievement of disciplinary learning outcomes (scales, tools, procedures and assessment criteria);
- tools, equipment and software;
- recommended sources of information.

The work program is designed to implement a competency approach in planning an education process, delivery of the academic discipline, preparing students for control activities, controlling the implementation of educational activities, internal and external quality assurance in higher education, accreditation of degree programs within the specialty.

Approved by the decision of the Scientific and Methodological Commission of the specialty 141 Electrical energetics, electrical engineering and electromechanics (protocol №21/22-07 of 14.07.2022).

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1 AIM OF THE DISCIPLINE

In the educational and professional program «Electrical energetics, electrical engineering and electromechanics» of the specialty 141 Electrical energetics, electrical engineering and electromechanics the distribution of program learning outcomes (PLO) for the organizational forms of the educational process is done. In particular, the following learning outcomes are attributed to the discipline Ф7 «Electronics, microprocessor technology and automation tools»:

ПР02	To know and understand the theoretical foundations of metrology and electrical measurements, the principles of automatic control devices, relay protection and automation, have the skills to perform appropriate measurements and use these devices to solve professional problems
ПР06	To apply application software, microcontrollers and microprocessor technology to solve practical problems in professional activities

The aim of the discipline is to form competences in the construction, principle of operation and analysis of processes in electronic circuits, microprocessor devices and sensors of automation systems, programming of microprocessor controllers.

The implementation of the aim requires transforming program learning outcomes into the disciplinary ones as well as an adequate selection of the contents of the discipline according to this criterion.

2 INTENDED DISCIPLINARY LEARNING OUTCOMES

Code PLO	**Disciplinary learning outcomes (DLO)**	
	Code DLO	**Content**
ПР02	ПР02.01-Ф7	To understand the purpose, principle of operation and parameters of electronic elements.
	ПР02.02-Ф7	To understand the purpose, principle of operation and parameters of analog electronic devices
	ПР02.03-Ф7	To understand the purpose, principle of operation and parameters of digital electronic devices
	ПР02.04-Ф7	To understand the purpose, principle of operation and parameters of secondary power sources
ПР06	ПР06.01-Ф7	To understand the architecture, structure, functionality of the basic microcontroller model, develop algorithms, compile and debug programs. Understand the principles of information display systems.
	ПР06.02-Ф7	Develop basic electrical schemes for connecting external devices and organize data exchange.
	ПР06.03-Ф7	Choose a controller and expansion modules to solve the task of automating a local industrial plant.
	ПР06.04-Ф7	Choose the type and model of the sensor, based on the task and conditions of detection, properties of the object and parameters of the environment, taking into account economic feasibility.

3 BASIC DISCIPLINES

Subjects	**Achieved learning outcomes**
Б1 Higher mathematics, Б2 General Physics,	ПР08 To select and apply suitable methods for analysis and synthesis of electromechanical and electrical systems with specified parameters.

Subjects	Achieved learning outcomes
	ПР07 To carry out analysis of processes in electrical, electrical and electromechanical equipment, relevant complexes and systems.
Б5 Theoretical foundations of electrical engineering	ПР05 To know the basics of the theory of the electromagnetic field, methods of calculating electric circuits and be able to use them to solve practical problems in professional activities.

4 WORKLOAD DISTRIBUTION BY THE FORM OF EDUCATIONAL PROCESS ORGANIZATION AND TYPES OF CLASSES

Type of classes	Workload *hours*	Distribution by forms of education, *hours*					
		Full-time		Part-time		Extramural	
		Classes (C)	Individual work (IW)	Classes (C)	Individual work (IW)	Classes (C)	Individual work (IW)
lectures	180	67	113	-	-	16	164
practical				-	-	-	-
laboratory	180	75	105	-	-	16	164
seminars	-	-	-	-	-	-	-
TOTAL	360	142	218	-	-	32	328

5 DISCIPLINE PROGRAM BY TYPES OF CLASSES

Code DLO	Types and topics of classes	Volume of components, *hours*
	3 semester (5-6 terms)	
	LECTURES	**90**
ПР02.01-Ф7	**1. Element base of electronics.** 1.1. Passive components of electronic circuits. 1.2. Electrophysical properties of semiconductors. 1.3. Classification and general characteristics of semiconductor devices. 1.4. Diode group devices. 1.5. Bipolar and field-effect transistors. 1.6. Thyristors. 1.7. IGBT transistors. 1.8. Elements of optoelectronics	20
ПР02.02-Ф7	**2. Analog electronic devices** 2.1. Parameters and characteristics of analog devices. 2.2. Electronic amplifiers of electrical signals. 2.3. Operational amplifiers, analog circuits for operational amplifiers. 2.4. Generators of sinusoidal oscillations.	20
ПР02.03-Ф7	**3. Digital electronic devices.** 3.1. Fundamentals of logic algebra and digital integrated circuits of logic elements 3.2. Sequential circuits: triggers, counters, registers. 3.3. Combination devices: encoders, decoders, adders, multiplexers. comparison schemes 3.4. Digital-to-analog and analog-to-digital converters (DAC and ADC).	20

ПР02.04-Ф7	**4. Secondary power sources.** 4.1. Uncontrolled rectifiers. Parameters and characteristics. 4.2. Schemes of single-phase and three-phase rectifiers. 4.3. Smoothing filters 4.4. Voltage and current stabilizers.	30
	LABORATORY WORKS	**90**
ПР02.01-Ф7	Study of structures, markings and images of radio components	6
	Investigation of semiconductor diodes and zener diodes	6
	Investigation of a bipolar transistor	6
	Thyristor research	6
	Calculation and study of low frequency amplifier on bipolar transistor	6
ПР02.02-Ф7	Calculation of amplifiers on the operational amplifier: inverting, non-inverting and sub-tracting	6
ПР02.02-Ф7	Investigation of of amplifiers on the operational amplifier: inverting, non-inverting and sub-tracting	6
ПР02.02-Ф7	Investigation of the generator of sinusoidal oscillations on the operational amplifier	6
ПР02.02-Ф7	Investigation of passive forming devices	6
ПР02.02-Ф7	Investigation of relaxation generators on the operational amplifier	6
ПР02.03-Ф7	Investigation of the basic element of transistor-transistor logic	6
ПР02.03-Ф7	Investigation of trigger circuits	6
ПР02.03-Ф7	Investigation of counters and registers	4
ПР02.03-Ф7	Investigation of DAC and ADC	8
ПР02.04-Ф7	Investigation of uncontrolled rectifier with filters	6
	Total for 3 semester:	**180**
	4 semester (7 term)	
	LECTURES	**45**
ПР06.01-Ф7	**1. Components of microprocessor devices. Number systems. General infor-mation about microprocessor systems. Implementation of arithmetic calcula-tions and performance of logical calculations**	5
	1.1. The purpose of the discipline. Methods of transmission, storage and processing of informatio.	
	1.2. Classification and purpose of microprocessor devices.	
	1.3. Number systems. Positional number systems.	
	1.4. Implementation of arithmetic and logical operations.	
ПР06.01-Ф7	**2. Single-chip microcontroller and single-chip microcontroller (OMC) com-mand system of the MCS-51 family**	20
	2.1. MCS-51 microcontroller architecture. Memory organization and registers.	
	2.2. MCS-51 microcontroller instruction system.	
	2.3. Groups and types of instructions.	
	2.4. Integrated Development Environment (IDE).	
	2.5. Low and high level programming languages.	
ПР06.01-Ф7	**3. Basic program constructs. Bit processor**	10

	3.1. Classification of typical program constructs.	
	3.2. Program implementation of arithmetic data processing and logical operations.	
	3.3. Implementation of basic program constructs. Branching (condition), cycles.	
	3.4. Bit processor. Discrete data processing.	
	3.5. Debugging programs.	
ПР06.01-Ф7, ПР06.02-Ф7	**4. Internal peripherals microcontrollers of the MCS-51 family microcontrollers**	10
	4.1. Parallel ports of the microcontroller. Purpose, modes of operation..	
	4.2. Circuitry of parallel ports.	
	4.3. External devices connection diagrams.	
	4.4. Parallel, discrete and serial communication via ports.	
	4.5. Timers / counters. Purpose, modes of operation.	
	4.6. Organization of time intervals. Generating signals with specified time parame-ters.	
	4.7. Interrupt system. Purposes and modes.	
	4.8. Processing of external interrupts and interrupts from built-in devices.	
	4.9. Universal asynchronous receiver / transmitter (UART). Purpose, circuitry, modes of operation.	
	4.10. Sequential data exchange. Point-to-point and bus networks.	
	LABORATORY WORKS	**45**
ПР06.01-Ф7	The architecture of the microcontroller 8051AH family MCS-51. Full-screen FD51 debugger-simulator.	5
ПР06.01-Ф7	MCS-51 family microcontroller instruction system. Typical program constructs.	8
ПР06.01-Ф7	Bit processor of the MCS-51 microcontroller. Programming in the integrated development environment IDE Keil uVision	8
ПР06.01-Ф7	Programming of arithmetic operations using microcontrollers of the MCS-51 family.	8
ПР06.01-Ф7 ПР06.02-Ф7	MCS-51 assembler. Training and adjusting stand EV8031 / AVR	8
ПР06.01-Ф7 ПР06.02-Ф7	Programming of data transmission in parallel format. Methods of displaying information.	8
	Total for 7 term:	**90**
	4 semester (8 term)	
	LECTURES	**45**
ПР06.03-Ф7	**1. Automation, its purpose. Classification of automated control systems and technical means of automation. Programmable logic controllers (PLCs). PLC programming languages**	6
	1.1. The purpose of automation of technological processes.	
	1.2. Classification of automatic and automated systems. Local automation systems.	

	1.3. Programmable logic controllers (PLCs). PLC programming languages.	
ПР06.03-Ф7	**2. PLC Zelio Logic: overview, technical capabilities, hardware configurations. Ladder Diagram programming language**	8
	2.1. PLC Zelio Logic: appointment technical capabilities.	
	2.2. Operating modes.	
	2.3. Zelio Analog interfaces.	
	2.4. Zelio Soft programming environment.	
	2.5. Ladder Diagram (LD) programming language.	
	2.6. Programming of typical tasks and logical functions	
	2.7. Debugging programs.	
ПР06.03-Ф7	**3. PLC Zelio Logic functions (internal program functional blocks)**	8
	3.1. Assignment of functions (internal function blocks).	
	3.2. Main functions: timers, counters, comparators.	
	3.3. Implementation of logic functions using ladder diagrams	
	3.4. Debugging programs.	
ПР06.03-Ф7	**4. Functional blocks programming using special functions (SFC)**	13
	4.1. Programming in the language of functional blocks (Functional Block Diagram, FBD)	
	4.2. Basic functions: timers, counters, comparators, cam controller.	
	4.3. Additional and service functional blocks.	
	4.4. Logical elements.	
	4.5. Grafcet special blocks (Special Functions, SFC).	
	4.6. Macros	
	4.7. Supervisor window.	
	4.8. Debugging programs.	
ПР06.04-Ф7	**5. Sensors of automation systems**	10
	5.1 Purpose, classification, types of industrial sensors. Principles of action.	
	5.2 Photoelectric sensors.	
	5.3 Inductive sensors.	
	5.4 Ultrasonic sensors.	
	5.5 Capacitive sensors.	
	5.6 Additional equipment.	
	5.7 Circuitry and connection of sensors.	
	5.8 Summary conclusions and recommendations for selection.	
	LABORATORY WORKS	**45**
ПР06.03-Ф7	1.ZelioSoft 2 software shell: purpose, interface, methods of work..	9
ПР06.03-Ф7	2.Implementation of logical functions in the language of Ladder diagrams.	4
ПР06.03-Ф7	3.Internal functions of Zelio modules: purpose, modes, programming methods.	6

ПР06.03-Ф7	4.Programming of a typical cyclic mechanism control task (LD language).	4
ПР06.03-Ф7	5.Programming a typical cyclic mechanism control task (FBD language).	6
ПР06.03-Ф7	6.Programming a typical control task of a cyclic mechanism (Grafcet language).	4
ПР06.04-Ф7	7.Research of photoelectric sensors.	4
ПР06.04-Ф7	8.Research of inductive sensors.	4
ПР06.04-Ф7	9.Research of ultrasonic and capacitive sensors.	4
	Total for 8 term	**90**
	Total for 4 semester	**180**
	TOTAL	**360**

For the implementation of the hybrid form of teaching students, the electronic resource of the e-learning in the discipline is used at the following address: **https://do.nmu.org.ua/course/view.php?id=3412**

6 KNOWLEDGE PROGRESS TESTING

Certification of student achievement is accomplished through transparent procedures based on objective criteria in accordance with the University Regulations “On Evaluation of Higher Education Applicants' Learning Outcomes”.

The level of competencies achieved in relation to the expectations, identified during the control activities, reflects the real result of the student's study of the discipline.

6.1 Grading scales

Assessment of academic achievement of students of the Dnipro University of Technology is carried out based on a rating (100-point) and institutional grading scales. The latter is necessary (in the official absence of a national scale) to convert (transfer) grades for mobile students.

The scales of assessment of learning outcomes of the DNIPROTECH students

Rating	Institutional
90 ... 100	відмінно / Excellent
74 ... 89	добре / Good
60 ... 73	задовільно / Satisfactory
0 ... 59	незадовільно / Fail

Discipline credits are scored if the student has a final grade of at least 60 points. A lower grade is considered to be an academic debt that is subject to liquidation in accordance with the Regulations on the Organization of the Educational Process of DNIPROTECH.

6.2 Tools and procedures

The content of diagnostic tools is aimed at controlling the level of knowledge, proficiency/skills, communication, autonomy, and responsibility of the student according to the requirements of the National Qualifications Framework (NQF) up to the 6^{th} qualification level during the demonstration of the learning outcomes

regulated by the work program.

During the control activities, the student should perform tasks focused solely on the demonstration of disciplinary learning outcomes (Section 2).

Diagnostic tools provided to students at the control activities in the form of tasks for the formative and summative knowledge progress testing are formed by specifying the initial data and a way of demonstrating disciplinary learning outcomes.

Diagnostic tools (control tasks) for the formative and summative knowledge progress testing are approved by the department.

Types of diagnostic tools and procedures for evaluating the formative and summative knowledge progress testing are given below.

Diagnostic and assessment procedures

FORMATIVE ASSESSMENT			**SUMMATIVE ASSESSMENT**	
training sessions	**diagnostic tools**	**procedures**	**diagnostic tools**	**procedures**
lectures	control tasks for each topic	performing the task during lectures		determination of the weighted average result of formative assessments;
laboratory	control tasks for each laboratory work	performing tasks during practical classes	complex control work (CCW)	performing CCW during the differentiated test at the request of the student

During the current control, lectures are evaluated by determining the quality of control specific tasks. Laboratory classes are assessed by the quality of the control task.

If the content of a certain type of classes is subordinated to several components of the description of the qualification level according to the NQF, the integral value of the grade can be determined taking into account the weighting coefficients set by the lecturer.

Provided that the level of results of the formative assessments of all types of training at least 60 points, the summative assessment can be carried out without the student's immediate participation by determining the weighted average value of the obtained grades.

Regardless of the results of the formative assessments, every student during the summative knowledge progress testing has the right to perform the CCW, which contains tasks covering key disciplinary learning outcomes.

The number of specific tasks of the CCW should be consistent with the allotted time for completion. The number of CCW options should ensure that the task is individualized.

The value of the mark for the implementation of the CCW is determined by the average evaluation of the components (specific tasks) and is final.

The integral value of the assessment of the implementation of the CCW can be determined taking into account the weighting coefficients established by the department for each component of the description of the qualification level of the NQF.

6.3 Criteria

Actual student learning outcomes are identified and measured relative to what is expected during the control activities using criteria that describe the student's actions to demonstrate the achievement of learning outcomes.

To assess the performance of control tasks during the formative assessment on lectures and laboratory classes the coefficient of mastery is used as a criterion, which automatically adapts the assessment indicator to the rating scale:

$$O_i = 100\ a/m,$$

where a is a number of correct answers or significant operations performed in accordance with the solution standard; m is the total number of questions or significant operations of the standard.

Individual tasks and complex control works are assessed expertly using criteria that characterize the ratio of requirements to the level of competencies and indicators of assessment on a rating scale.

The content of the criteria is based on the competency characteristics defined by the NQF for the bachelor's level of higher education (given below).

General criteria for achieving learning outcomes for the 6th qualification level of NQF (bachelor)

Description of qualification level	**Requirements for knowledge, proficiency/skills, communication, autonomy and responsibility**	**Indicator evaluation**
Knowleges		
Conceptual scientific and practical knowledge, critical understanding of theories, principles, methods and concepts in the field of professional activity and / or training	The answer is excellent - correct, reasonable, meaningful. Characterizes the presence of: - conceptual knowledge; - high degree of knowledge of the state of the art; - critical understanding of the basic theories, principles, methods and concepts in education and professional activity	95-100
	The answer contains minor errors or omissions	90-94
	The answer is correct, but has some inaccuracies	85-89
	The answer is correct, but has some inaccuracies and is insufficiently substantiated	80-84
	The answer is correct, but has some inaccuracies, insufficiently substantiated and meaningful	74-79
	The answer is fragmentary	70-73
	The answer shows the student's vague ideas about the object of study	65-69
	The level of knowledge is minimally satisfactory	60-64
	The level of knowledge is unsatisfactory	<60
Proficiency/Skills		

Description of qualification level	Requirements for knowledge, proficiency/skills, communication, autonomy and responsibility	Indicator evaluation
In-depth cognitive and practical skills, mastery and innovation at the level required to solve complex specialized tasks and practical problems in the field of professional activity or training	The answer characterizes the ability to: - identify problems; - formulate hypotheses; - solve problems; - choose appropriate methods and tools; - collect and interpret information logically and clearly; - use innovative approaches to solving problems	95-100
	The answer characterizes the ability to apply knowledge in practice with minor errors	90-94
	The answer characterizes the ability to apply knowledge in practice, but has some inaccuracies in the implementation of one requirement	85-89
	The answer characterizes the ability to apply knowledge in practice, but has some inaccuracies in the implementation of the two requirements	80-84
	The answer characterizes the ability to apply knowledge in practice, but has some inaccuracies in the implementation of the three requirements	74-79
	The answer characterizes the ability to apply knowledge in practice, but has some inaccuracies in the implementation of the four requirements	70-73
	The answer characterizes the ability to apply knowledge in practice when performing tasks on the model	65-69
	The answer characterizes the ability to apply knowledge in performing tasks on the model, but with inaccuracies	60-64
	The level of skills is unsatisfactory	<60
Communication		
♦ reporting to specialists and non-specialists information, ideas, problems, solutions, own experience and argumentation ♦ data collection, interpretation and application ♦ communication on professional issues, including in a foreign language, orally and in writing	Fluency in industry issues. Clarity of the answer (report). Language: - correct; - clean; - clear; - accurate; - logical; - expressive; - concise. Communication strategy: - consistent and consistent development of thought; - the presence of logical own judgments; - appropriate reasoning and its compliance with the defended provisions; - correct structure of the answer (report); - correct answers to questions; - appropriate technique for answering questions; - ability to draw conclusions and formulate proposals;	95-100
	Sufficient knowledge of industry issues with minor flaws. Sufficient clarity of the answer (report) with minor flaws.	90-94

Description of qualification level	Requirements for knowledge, proficiency/skills, communication, autonomy and responsibility	Indicator evaluation
	Relevant communication strategy with minor flaws.	
	Good knowledge of industry issues. Good clarity of the answer (report) and appropriate communication strategy (three requirements in total are not realized)	85-89
	Good knowledge of industry issues. Good clarity of the answer (report) and appropriate communication strategy (four requirements not implemented in total)	80-84
	Good knowledge of industry issues. Good clarity of the answer (report) and appropriate communication strategy (five requirements not implemented in total)	74-79
	Satisfactory knowledge of industry issues. Satisfactory clarity of the answer (report) and appropriate communication strategy (a total of seven requirements have not been implemented)	70-73
	Partial knowledge of industry issues. Satisfactory clarity of the answer (report) and communication strategy with errors (a total of nine requirements are not implemented)	65-69
	Partial knowledge of industry issues. Satisfactory clarity of the answer (report) and communication strategy with errors (a total of 10 requirements are not implemented)	60-64
	The level of communication is unsatisfactory	<60
Autonomy and responsibility		
♦ managing complex technical or professional activities or projects ♦ ability to take responsibility for making and making decisions in unpredictable work and / or learning contexts ♦ formation of judgments that take into account social, scientific and ethical aspects ♦ organization and management of professional development of individuals and groups	Excellent command of personal management competencies focused on: 1) management of complex projects, which involves: - research nature of educational activities, marked by the ability to independently assess various life situations, phenomena, facts, identify and defend a personal position; - ability to work in a team; - control of own actions; 2) responsibility for decision-making in unpredictable conditions, including: - justification of own decisions by the provisions of the regulatory framework of the industry and state levels; - independence in the performance of tasks; - initiative in discussing problems; - responsibility for relationships; 3) responsibility for the professional development of individuals and/or groups of individuals, which involves - use of professionally oriented skills; - use of evidence with independent and correct argumentation; - mastery of all types of learning activities;	95-100

Description of qualification level	Requirements for knowledge, proficiency/skills, communication, autonomy and responsibility	Indicator evaluation
♦ ability to continue studies with a significant degree of autonomy	4) the ability to continue learning with a high level of autonomy, which includes - the degree of mastery of fundamental knowledge; - independence of evaluative judgments; - a high level of general learning skills; - - independent search and analysis of information sources	
	Good mastery of personality management competencies (two requirements not met)	90-94
	Good mastery of personality management competencies (three requirements not met)	85-89
	Good mastery of personality management competencies (four requirements not met)	80-84
	Good mastery of personality management competencies (six requirements not met)	74-79
	Satisfactory mastery of personality management competencies (seven requirements not met)	70-73
	Satisfactory mastery of personality management competencies (eight requirements not met)	65-69
	The level of responsibility and autonomy is fragmentary	60-64
	The level of autonomy and responsibility is unsatisfactory	<60

7 TOOLS, EQUIPMENT AND SOFTWARE

Technical means of training.

Remote platform MOODLE, MS Teams.

Specialized software – Multisim 11.0 software package, ZelioSoft 2 software package, FD51, integrated develolopment environment Keil uVision.

8 RECOMMENDED SOURCES OF INFORMATION

Basic:

1. Основи електроніки : навч. посіб. / А. С. Васюра, Г. Д. Дорощенков, В. П. Кожем’яко, Г. Л. Лисенко. – Вінниця : ВНТУ, 2018. – 197 с.
2. Болюх В. Ф., Данько В. Г. Основи електроніки і мікропроцесорної техніки: Навч. посібник. – Харків: НТУ «ХПІ», 2011. – 257 с.
3. Гикавий В. А. Цифрова і аналогова схемотехніка / В. А. Гикавий. – Вінниця : ВДТУ, 2001. – 161 с..
4. Колонтаєвський Ю.П., Соколов А.Г. Електроніка і мікросхемотехника. Підручник (2-е вид.) / За ред. А.Г. Соскова. – К.: Каравелла, 2009. – 416 с.
5. Стахів П. Г. Основи електроніки: функціональні елементи та їх застосування: навч. посіб. / П. Г. Стахів., В. І. Коруд, О. С. – Л. : Вид-во Нац. ун-ту „Львівська політехніка”, 2002. – 120 с.
6. Колонтаєвський Ю. П. Конспект лекцій з дисципліни «Мікропроцесорна техніка» (для студентів, які навчаються за напрямом 6.050701 – Електротехніка та електротехнології всіх форм навчання) / Ю. П.

Колонтаєвський; Харків. нац. ун-т міськ. госп-ва ім. О. М. Бекетова. – Харків : ХНУМГ ім. О. М. Бекетова, 2016. – 78 с.
7. Мікропроцесорна техніка [Текст]: навч. посібник/ В.В. Ткачов, Г. Грулер, М-59 Н. Нойбергер та ін. – Д.: Національний гірничий університет, 2012. – 188 с.
8. Технічні засоби автоматизації : навч.-метод. посібник / уклад.: А.К. Бабіченко, М. О. Подустов, І. Л. Красніков, О. Г. Шутинський, І. Г. Лисаченко, Ю. А. Бабіченко, О. М. Дзевочко, В. І. Вельма, О.В.Пугановський ; за ред. А. К. Бабіченка. – Х.: НТУ «ХПІ», 2021. – 217 с.
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