National Technical University of Ukraine
Igor Sikorsky Kyiv Polytechnic Institute "

Department of
Electromechanical Systems
Automation and Electrical
Drives

AUTOMATION SYSTEMS. PART 2. PROGRAMMABLE LOGIC CONTROLLERS

Syllabus of educational component

Details of the academic discipline	
Level of higher education	***First (undergraduate)***
Discipline	*14 "Electrical engineering"*
Specialty	*141 "Electric power engineering, electrical engineering and electromechanics"*
Educational program	*Electromechanical automation systems, electric drive and electric mobility*
Discipline status	*Mandatory*
Form of education	*Daytime*
Year of training, semester	*II I year, fall semester (full-time)* *1st year , fall semester (full-time accelerated)*
Scope of the discipline	*6 ECTS credits / 180 hours (36 hours of lectures, 18 hours of practical classes; 36 hours of laboratory work)*
Semester control/ control measures	*Examination/testing, RGR, MKR, protection of laboratory work*
Class schedule	*1 lecture (2 hours) once a week;* *1 practical session (2 hours) once every 2 weeks;* *1 laboratory work (4 hours) once every 2 weeks.*
Language of teaching	*Ukrainian*
Information about the head of the course / teachers	*Lecturer* : *Ph.D. Serhiy Oleksandrovich Buryan , 0508403155* Practical classes: *Ph.D. Serhiy Oleksandrovich Buryan , 0508403155* Laboratory works: *Zemlyanukhina Hanna Yuriivna, 0973875085* *Ph.D. Roman Serhiyevich Volyanskyi , 0674985064*
Placement of the course	*https://do.ipo.kpi.ua/course/view.php?id=1770*

Program of study discipline

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

Syllabus of the educational component " Automation systems. Part 2 " was compiled in accordance with the bachelor's educational program " Electromechanical systems of automation, electric drive and electromobility " (version of 2024) specialty 141 - Electric power engineering, electrical engineering and electromechanics.

The purpose of the educational discipline *there is the formation and consolidation of the following competencies in students : (Z K01) Ability to abstract thinking, analysis and synthesis; (ZK03) Ability to communicate in the state language both orally and in writing; (ZK05) Ability to search, process* *and analyze information from various sources; (ZK06) Ability to identify, pose and solve problems; (ZK07) Ability to work in a team; (ZK08) Ability to work autonomously ; (FK01) Ability to solve practical problems using automated design and calculation systems (CAD); (FC14) Ability to solve complex problems of logical synthesis related to the operation of discrete automation systems and microprocessor devices.*

The subject of the educational discipline *is advanced methods of synthesis of multi-step automation schemes, which are used in their technical implementation in the form of control algorithms for programmable logic controllers.*

Program learning outcomes, the formation and improvement of which the discipline is aimed at: *(PRN06) Apply application software, microcontrollers and microprocessor technology to solve practical problems in professional activities ; (PRN08) Choose and apply suitable methods for the analysis and synthesis of electromechanical and electric power systems with specified indicators; (PRN10) Find the necessary information in scientific and technical literature, databases and other sources of information, evaluate it relevance and reliability; (PRN11) Communicate freely about professional problems in national and foreign languages orally and in writing, discuss the results of professional activity with specialists and non-specialists, argue one's position on debatable issues; (PRN18) To be able to learn independently, acquire new knowledge and improve the skills of working with modern equipment, measuring equipment and application software; (PRN21) Know and understand the principles of operation of integrated microcircuits, programmable logic controllers and programmable logic integrated circuits; (PRN23) To be able to apply the laws of algebra-logic, code conversion, Carnot maps, the basis of transition tables, graph transitions , cyclograms and multiplexers -selectors for the synthesis of logic control schemes for automation systems; (PRN24) To be able to apply the methods of synthesis of discrete automation circuits to compile programs for programmable logic relays and programmable logic integrated circuits, to select equipment when designing discrete automation systems, to compile logic circuits on microcircuits using a modern element base; (PRN28) Develop design and construction documentation for control schemes of electromechanical systems; program microprocessors, microcontrollers, programmable logic integrated circuits and logic controllers and use them to implement algorithms for controlling electric drives.*

2. Prerequisites and postrequisites of the discipline

To successfully master the discipline, the student must possess the educational components "Synthesis of logical schemes" and "Automation systems. Part 1". Competencies, knowledge and skills acquired in the process of studying the educational component are necessary for further study of the educational components "Automated electric drive" and "Electromechanical systems of typical technological applications".

3. Content of the academic discipline

Chapter 6 . Low-level programmable logic controllers.

Topic 6.1. Basic information about programmable logic controllers.

Topic 6.2. Configuration of inputs and outputs of programmable logic controllers.

Topic 6.3. Schemes of connecting typical devices of automation systems to programmable logic controllers.

Chapter 7. Programming logic controllers

Topic 7.1. Fundamentals of logic controller programming in the IL language .

Topic 7.2. Examples of programming for logic controllers in the IL language .

Topic 7.3 Fundamentals of programming logic controllers in the LD language .

Topic 7.4. Examples of programming for logic controllers in the LD language .

Topic 7.5 Basics of programming logic controllers in the FBD language .

Topic 7.6. Examples of programming for logic controllers in the FBD language .

Topic 7.7. Modified logic controller programming languages.

Topic 7.8. Conversion of known relay- contactor schemes for compiling programs for logic controllers.

Topic 7.9. Conversion of complex relay- contactor schemes into a program for a logic controller.

Topic 7.10. Examples of compiling complex programs for logic controllers under specified operating conditions.

Chapter 8. Fundamentals of digital circuitry

Topic 8.1. General information about integrated circuits.

Topic 8.2. Fundamentals of circuit engineering of transistor -transistor logic elements.

Topic 8.3. Fundamentals of circuit technology of transistor -transistor logic with Schottky diodes .

Topic 8.4. Basics of circuit technology of emitter-coupled logic

Topic 8.5. Basics of KMDN-logic circuitry.

4. Educational materials and resources

Basic literature

1. Kovalchuk O.V. Logical synthesis of discrete automation schemes: a study guide - K.: NTUU "KPI", 2008. - 168 p. ISBN 978-966-622-294-0.

2. Automation systems. Laboratory practice. Part 2 [Electronic resource]: study guide for bachelor's degree holders of the educational program "Electromechanical systems of automation, electric drive and electric mobility " specialty 141 "Electric power, electrical engineering and electromechanics" / KPI named after Igor Sikorskyi; compilers: S. O. Buryan, G. Yu. Zemlyanukhina , R. S. Volyanskyi . – Electronic text data (1 file: 5.63 MB). – Kyiv: KPI named after Igor Sikorskyi, 2023. – 208 p. – Title from the screen. (Griff provided by the Methodical Council of Igor Sikorsky Kyiv Polytechnic Institute, protocol No. 5 dated 02/23/2023, at the request of the Academic Council of the Faculty of Electrical Engineering and Automation, protocol No. 7 dated 01/30/2023). Placement address https://ela.kpi.ua/handle/123456789/53964

3. Automation of technological processes, installations and complexes - 1 [Electronic resource]: a course of lectures for students of the training direction 6.050702 "Electromechanics" of the specialty "Electromechanical systems of automation and electric drive" full-time study / NTUU "KPI"; structure. O. V. Kovalchuk, S. O. Buryan. – Electronic text data (1 file: 26.3 MB). - Kyiv: NTUU "KPI", 2011. - Title from the screen (access via the link https://ela.kpi.ua/handle/123456789/932).

4. Automation of technological processes, installations and complexes - 2 [Electronic resource]: synopsis of lectures from the credit module for students of the training direction 6.050702 "Electromechanics", specialty "Electromechanical systems of automation and electric drive" full-time study / NTUU "KPI"; structure. O. V. Kovalchuk, S. O. Buryan. – Electronic text data (1 file: 7.63 MB). – Kyiv: NTUU "KPI", 2010. - Title from the screen. (access via the link https://ela.kpi.ua/handle/123456789/821).

5. I.M. Bondarenko, O.V. Borodin, V.P. Karnaushenko Modern component base of electronic systems: training . a guide for students of higher education institutions. / I.M. Bondarenko, O.V. Borodin, V.P. Karnaushenko . – Kharkiv: Khnure, 2020. – 268 p. (access via the link https://openarchive.nure.ua/bitstream/document/14062/3/SKB_2020.pdf).

6. Senko V. I. and others. Electronics and microcircuit technology : In 4 vols. Volume 3. Digital devices: Textbook/Ed. VI Senka //K.: Caravela. - 2008.

Additional literature

7. Buryan S.O. Logical synthesis of discrete automatic control systems using programmable low-level relays / S.O. Buryan, M.V. Pechenyk , G.Yu. Zemlyanukhina , I.S. Epifantsev // Collection of

Scientific Works of Admiral Makarov National Shipbuilding University. – 2021 - #1 (484). – P. 54-60 (access via link https://doi.org/10.15589/znp2021.1(484).7) .

8. Kovalchuk, O. V., Buryan, S. O. (2010). Application of various methods in synthesis for complex programs for logical programmable controllers. Promelectro information collection . "Industrial electronics and electrical engineering". (4). 51–53 (access via link https://ela.kpi.ua/bitstream/123456789/38235/1/09.pdf).

9. Rabbie, Max (2018). Programmable Logic Controllers: hardware and programming. ISBN: 9781631269325 (access via the link https://cutt.ly/IChInHV) .

10. Petruzella , Frank D. (2017). Programmable logic controllers. ISBN 978-0-07-337384-3. (access via link https://cutt.ly/1ChIL4e) .

11. Hanssen , Dag H a kon (2015) . Programmable Logic Controllers : A Practical Approach to IEC 61131-3 using CODESYS . ISBN 978-1-118-94924-5 (access by link https://cutt.ly/ZChUZus).

12. Khaled Camel , Eman Kamel (2014). Programmable Logic Controllers. Industrial Control. ISBN: 978-0-07-181047-0 (access via the link https://cutt.ly/VChIr20) .

13. Hugh Jack (2007) . Automation Manufacturing Systems with PLCs . Version 5.0 . 839 p . (access via link https :// cutt . ly / IChTOJz).

14. Vingron , SP (2012). Logic circuit design : Selected methods . Springer Science & Business Media .

15. F. Basile , P. Chiacchio and D. Gerbasio , " On the Implementation of Industrial Automation Systems Based on PLC," in IEEE Transactions he Automation Science and Engineering , vol . 10, no . 4, pp . 990-1003 , Oct. 2013, doi : 10.1109/TASE.2012.2226578 (accessed by reference https://ieeexplore.ieee.org/document/6381490) .

Educational content

5. Methods of mastering an educational discipline (educational component)

Lecture classes

No s/p	*The name of the topic of the lecture and a list of main questions (list of didactic tools, links to information sources)*
1	***Topic 6.1. Basic information about programmable logic controllers.***
2	***Topic 6.2. Configuration of inputs and outputs of programmable logic controllers.***
3	***Topic 6.3. Schemes of connecting typical devices of automation systems to programmable logic controllers.***
4	***Topic 7.1. Fundamentals of logic controller programming in the IL language.***
5	***Topic 7.2. Examples of programming for logic controllers in the IL language.***
6	***Topic 7.3 Fundamentals of logic controller programming in the LD language.***
7	***Topic 7.4. Examples of programming for logic controllers in the LD language.***
8	***Topic 7.5 Fundamentals of logic controller programming in the FBD language.***
9	***Topic 7.6. Examples of programming for logic controllers in the FBD language.***
10	***Topic 7.7. Modified logic controller programming languages.***
11	***Topic 7.8. Conversion of known relay- contactor schemes for compiling programs for logic controllers.***
12	***Topic 7.9. Conversion of complex relay- contactor schemes into a program for a logic controller.***
13	***Topic 7.10. Examples of compiling complex programs for logic controllers under specified operating conditions.***
14	***Topic 8.1. General information about integrated circuits.***
15	***Topic 8.2. Fundamentals of circuit engineering of transistor -transistor logic elements.***

16	***Topic 8.3. Fundamentals of circuit technology of transistor -transistor logic with Schottky diodes .***
17	***Topic 8.4. Basics of circuit technology of emitter-coupled logic***
18	***Topic 8.5. Basics of KMDN-logic circuitry.***

Practical classes

No s/p	*Name of the subject of the lesson and list of main questions*
1	***Practical lesson No. 1. The basics of working in the CoDeSys environment*** *Main questions: general information about the CoDeSys environment ; creating a program project in the LD language; variable addressing; compiling a program in the LD language based on equations that describe a one-cycle circuit; launch and simulation of the program; compiling a program in the LD language based on equations that describe a cyclogram with time delays; peculiarities of working with TON type timers.* *Video lesson: https://youtu.be/ufR8k8vz3GA* *Supporting materials*: https://do.ipo.kpi.ua/mod/folder/view.php?id=132869*
2	***Practical lesson #2. Working with triggers and static visualization in the CoDeSys environment*** *The main issues: compiling programs in the LD language in the CoDeSys environment based on the equations that were obtained as a result of the synthesis by the method of graph transitions on RS-triggers, using SET and RES coils; the basics of working in the Visualizations module of the CoDeSys environment ; an example of creating a visualization for an example of a dosing device; an example of creating a visualization for a problem whose conditions are given by a cyclogram.* *Video lesson: https://youtu.be/Lb03QmS1bhs* *Supporting materials*: https://do.ipo.kpi.ua/mod/folder/view.php?id=135231*
3	***Practical lesson No. 3. The basics of working in the LRX Software environment*** *Basic questions: the basics of working in software for programming PLCs from Lovato LRX Software ; general overview of the program menu; creation of a program in the LD language based on the results of synthesis on RS-triggers; features of the simulation of the developed program; assembling a program for a scheme that works in two modes without using jump commands.* *Video lesson: https://youtu.be/YL0P3YZZ6kU* *Supporting materials*: https://do.ipo.kpi.ua/mod/folder/view.php?id=136868*
4	***Practical lesson No. 4. The basics of working in the Zelio environment Soft 2*** *Main questions: the task of controlling the frequency of rotation of an asynchronous motor using a frequency converter operating in the "digital potentiometer" mode; calculation of timers for a given engine rotation trajectory; assembling a graph transition based on a given rotation trajectory; the basics of working in the Zelio environment Soft 2; compiling a program in the LD language based on the results of the synthesis of the given engine rotation trajectory; simulation and verification of the developed program.* *Video lesson: https://youtu.be/_keHifYWJwk* *Auxiliary materials*: https://do.ipo.kpi.ua/mod/folder/view.php?id=138716*
5	***Practical lesson No. 5. Basics of programming in the IL language in the CoDeSys environment . Part 1*** *Main questions: basic operations of the IL language in the programming environment for CoDeSys PLC programming ; an example of writing a program for a single-cycle circuit; an example of writing a program based on the equations obtained as a result of the synthesis of the problem by the cyclogram method; syntax for creating timers in the IL language; use*

	of transition commands in the IL language; an example of creating a program using jump commands. *Video lesson: https://youtu.be/3YroPdjeX0A* *Auxiliary materials*: https://do.ipo.kpi.ua/mod/folder/view.php?id=140744*
6	***Practical lesson No. 6. Basics of programming in the IL language in the CoDeSys environment . Part 2*** *Main questions: rules for working with the SET and RES commands of the IL language in the programming environment for CoDeSys PLC programming ; an example of writing a program based on the equations obtained as a result of problem synthesis by the method of graph transitions on RS-triggers; modification of the written program by adding a timer to one of the states.* *Video lesson: https://youtu.be/zXulNV1jKo4* *Auxiliary materials *: https://do.ipo.kpi.ua/mod/folder/view.php?id=142732*
7	***Practical lesson No. 7. Working with counters in the CoDeSys environment*** *Main questions: the use of counters in the CoDeSys environment in the LD language; adding and subtracting counters; an example of compiling a program in the LD language under given operating conditions using summing counters and timers.* *Video lesson: https://youtu.be/ppVkixhAIso* *Auxiliary materials *: https://do.ipo.kpi.ua/mod/folder/view.php?id=144402*
8	***Practical lesson #8. Fundamentals of programming in the FBD language in the Alfa environment Software*** *Key questions: Overview of the Alfa environment Software for programming Mitsubishi Alfa series PLCs ; basic blocks of the FBD programming language: logical elements, timers, triggers; an example of programming in the FBD language using timers and triggers.* *Video lesson: https://youtu.be/LR4pNn2nxn8* *Auxiliary materials *: https://do.ipo.kpi.ua/mod/folder/view.php?id=145780*
9	***Practical lesson 9 . The basics of working in the Siemens environment Logo***

** Supporting materials for lectures and practical classes are available for download only to applicants who are registered for the distance course "Automation Systems-2" on the Distance Learning Platform "Sikorsky" (link to the distance course in the Moodle environment https://do.ipo.kpi.ua/course/view.php?id=1770).*

Laboratory work

No s/p	*List of laboratory works*
1	***Laboratory work #1 0 . The solution of logical problems of automatic control based on the lovato LRD20RA024 programmable controller*** *The purpose of the work is to study the structure and principle of operation of the LOVATO LRD20RA024 programmable controller, to practically work out the rules of programming, writing and testing programs.*
2	***Laboratory work #11. Study of systems for working out given trajectories based on Altivar frequency converter and Zelio programmable logic controller Logic*** *The purpose of the work is to study the structure and principle of operation of the Zel io programmable controller Logic SR 3B102BD, learn to program in Zelio software Soft 2 and compile and debug programs for working out given trajectories.*
3	***Laboratory work #12. Research of the automation system based on the RF-202m industrial robot***

	The purpose of the work is to study the structure and principle of operation of the RF-202m industrial robot, to learn how to work in the Lectus OPC and SimpLight software environment , to compile programs for the robot to work out given trajectories .
4	***Laboratory work #13. Study of the automation system of pumping plants*** *The goal of the work is to learn how to solve automation problems of pumping units for pumping liquids based on discrete level sensors and to write appropriate programs in the LD language for the Lovato programmable controller .*
5	***Laboratory work #14. Synthesis and research of decimal number generators based on Hitachi-a23drp programmable logic controller and LED indicator*** *The purpose of the work is to learn how to synthesize logical expressions for decimal number generators using the RS-trigger method, to develop a program for a programmable logic controller based on these expressions, and to test the operation of the generator.*
6	***Laboratory work #15. Exploring Lovato lrd20ra024 Programmable Logic Controllers with Expansion Modules and LED Indicators*** *The goal of the work is to learn how to co-program the LOVATOLRD20RA024 controller with expansion modules for processing multi-clock circuits.*
7	***Laboratory work #16. Research of the belt conveyor automation system*** *The purpose of the work is to gain practical skills in working with a logic controller and a frequency converter in the conditions of belt conveyor control*
8	***Laboratory work #17. Implementation of automation systems based on Mitsubishi logic controller Alpha .*** *The purpose of the work is to get acquainted with the principles of development and testing of automation systems using the "ALPHA Programming " software environment, to learn in practice the process of creating and debugging programs in the language of functional blocks (FBD).*
9	***Laboratory work #18. Synthesis and research of automation systems based on Siemens logic controllers Logo .*** *The purpose of the work is to study the structure and principle of operation of the Siemens programmable controller logo ! 12/24RCE, the principle of operation of two controllers together according to Master-Slave technology , and practice the rules of programming, writing and working out programs.*

Calculation and graphic work (RGR)

As an individual task, students perform calculation and graphic work (RGR). The purpose of RGR is to consolidate students' practical skills to design an automation system based on a programmable logic controller according to the given operating conditions of the technological process. The task for the RGR is issued at the first practical session.

Student's independent work (SRS)

No s/p	*Type of independent work*	*Number hours of SRS*
1	*Preparation for laboratory work*	*25*
2	*Preparation for practical classes*	*18*
3	*Preparation for MKR*	*2*
4	*Implementation of RGR*	*15*
5	*Preparation for the exam*	*30*
	Total hours of SRS	***90***

6. Control work

The purpose of the test work is to consolidate and verify theoretical knowledge from the educational component, students to acquire practical skills of independent problem solving and the compilation and compilation of programs.

The modular control work (MKR) is completed after studying Sections 6-7 and completing practical classes 1-5. Control work is carried out in the Moodle environment . Each student receives an individual task, according to which it is necessary to perform the synthesis of a multi-cycle circuit on multiplexers and triggers, to compile programs in the CoDeSys environment in the LD language , to perform simulation and visualization.

Policy and control

6. Policy of academic discipline (educational component)

The system of requirements that the teacher sets before the student:

- *rules for attending classes: it is forbidden to evaluate the presence or absence of the winner in the classroom class, including the awarding of incentive or penalty points. According to the RSO of this discipline, points are awarded for the relevant types of educational activity in lectures and practical classes.*
- *rules of behavior in classes: the student has the opportunity to receive points for the appropriate types of educational activity in lectures and practical classes, provided for by the RSO of the discipline. The use of means of communication to search for information on the teacher's Google Drive, on the Internet, in a distance course on the Sikorsky platform is carried out on the condition that the teacher instructs;*
- *while working with teachers in practical classes, laboratory works, as well as during the direct defense of works provided by the RSO, the student must be connected to the appropriate conference with the camera constantly on.*
- ***deadline and rescheduling policy:***
  - *if the student did not pass or did not appear at the MKR (without a good reason), his result is evaluated at 0 points. Redrafting of the MKR is not foreseen;*
  - *in the absence of a student at a practical lesson or laboratory work, he receives a personal task from the teacher;*
  - *any defenses of laboratory works and tasks from practical classes are not possible during the additional session, if the student did not attend more than 50% of the relevant classes;*
- *policy on academic integrity: the Code of Honor of the National Technical University of Ukraine "Kyiv Polytechnic Institute" https://kpi.ua/files/honorcode.pdf establishes general moral principles, rules of ethical behavior of individuals and provides a policy of academic integrity for persons working and studying at the university, which they should be guided by in their activities, including when studying and preparing control measures in the discipline "Automation Systems";*
- *when using digital means of communication with the teacher (mobile communication, e-mail, correspondence on forums and social networks, etc.), it is necessary to observe generally accepted ethical norms, in particular, be polite and limit communication to the working hours of the teacher;*
- *recognition of learning results acquired in non-formal/ informal education is carried out in accordance with the "Regulations on recognition in KPI named after Igor Sikorskyi of learning outcomes acquired in non-formal/ informal education". Courses (including online), seminars, trainings, etc. related to the subject of this discipline may be recognized.*

7. Types of control and rating system for evaluating learning outcomes (RSO)

***Current control** : surveys at lectures, MKR, performance of RGR, performance of tasks for practical classes, performance and defense of laboratory work.*

Calendar control *: is carried out twice a semester as a monitoring of the current state of meeting the requirements of the syllabus .*

Semester control: *exam.*

Conditions for admission to semester control *: completed and defended laboratory work, completed tasks for practical classes, semester rating of more than 30 points.*

Table of correspondence of rating points to grades on the university scale:

Number of points	*Rating*
95-100	*Perfectly*
85-94	*Very good*
75-84	*Good*
65-74	*Satisfactorily*
60-64	*Enough*
Less than 60	*Unsatisfactorily*
Less than 30	*Not allowed*

The student's overall rating after the end of the semester consists of points obtained for:

- *performance of tasks for practical classes;*
- *performance and protection of laboratory work;*
- *execution of modular control work (MCR);*
- *execution of calculation and graphic work (RGR);*
- *exam answers.*

Practical classes	*Laboratory work*	*MKR*	*RGR*	*Exam*
18	*18*	*9*	*15*	*40*

Practical classes

Weight score 2 *. The maximum number of points for all practical classes is 2 points * 9 classes = 18 points.*

At practical classes, students perform tasks under the supervision of a teacher. Each practical session contains a main (maximum point 1) and an additional (maximum point 1) task. Completion of the main task is mandatory , and the additional one is at the student's request.

Evaluation criteria

- the task was passed in a practical lesson - 1 point;

- the assignment was submitted within no more than 2 weeks after the practical session - 0.5 points;

- the assignment was submitted more than 2 weeks after the practical session - 0.2 points;

- the task is solved with errors - it is returned for revision (in case of minor errors, the task can be credited to the teacher at the student's request with a reduced grade of 0.2 to 0.5 points).

WARNING! *Solving and submitting all mandatory tasks for practical classes is a condition for admission to the exam. Students who, at the time of the consultation before the exam, have not passed the mandatory tasks for practical classes, are not allowed to take the main test and are preparing for a retake.*

WARNING! *In order to be allowed to retake the exam, it is necessary to hand in all the debts for the mandatory assignments for practical classes within the deadline set by the teacher .*

Laboratory work

The weighted point for one laboratory work is 2. *The maximum number of points for all laboratory works is 2 points * 9 works = 18 points.*

In laboratory work, students check the functionality of written programs or schemes based on previously solved tasks at home. For admission to current laboratory work, it is necessary to have a Protocol drawn up in accordance with the norms of drawing up technical documentation, which must contain all the necessary points, in accordance with the Methodological Instructions. Also, for admission to laboratory work (except for the 1st), it is necessary to protect the previous one. Students who have not defended the previous laboratory work may not be allowed to perform the next one. All laboratory work is performed by the team.

Criteria for evaluating laboratory work with a weighted score:

- correctly completed synthesis of all tasks, demonstrated efficiency of all programs (schemes), correct answers to defense questions - 2 points;

- correctly completed synthesis of all tasks, demonstrated efficiency of all programs (schemes), answers to defense questions have inaccuracies - 1.5-1.9 points;

- the synthesis of all tasks is completed, but some of them contain errors or inaccuracies, the functionality of not all programs (schemes) is demonstrated, the answers to the defense questions have inaccuracies - 1-1.4 points;

- the synthesis of not all tasks was performed, the performance of not all programs (schemes) was demonstrated, the answers to the defense questions were inaccurate - 0-0.9 points;

- the laboratory work is not completed or the protocol is not submitted - it is returned for revision or revision.

WARNING! *Defense of all laboratory work is a condition for admission to the exam. Students who, at the time of the consultation before the exam, have not defended the laboratory work, are not allowed to take the main exam and are preparing for a retake.*

WARNING! *In order to be allowed to retake the exam, it is necessary to pass all laboratory work debts within the deadline set by the teacher.*

Calculation and graphic work

The weighted score is 15. *The maximum number of points for the RGR is 15.*

The task for calculation and graphic work (RGR) is given to students at the first practical session.

In order to receive the maximum score, students must complete the RGR within the deadline set by the teacher and complete it in accordance with the established requirements. After completing the task and completing the RGR, each student must demonstrate the functionality of the developed automation system in the CoDeSys environment by developing an appropriate visualization of the technological process and answer the teacher's questions.

RGR evaluation criteria:

- the task was completed correctly, the RGR was designed in accordance with the requirements, the simulation results correspond to the task, the student answered the question correctly - 14-15 points;

- the task was completed with insignificant inaccuracies , the RGR was prepared in accordance with the requirements with some comments, the simulation results correspond to the task with minor errors, the student answered the question correctly - 10-13.9 points;

- the task was completed with significant inaccuracies , the RGR was not designed according to the requirements, the simulation results partially correspond to the task, the student answered the questions with errors - -5-9.9 points;

- the task was completed with significant inaccuracies , the RGR was not designed according to the requirements, the simulation results did not correspond to the task, the student answered the questions with errors - 0.1-4.9 points.

Modular control work

The weighted score is 9. *The modular control work (MCW) is performed during the semester in one of the practical classes after studying Section 1 and completing practical classes 1-5.*

Evaluation criteria for modular test work:

The student completes 2 tasks in the modular control work. The first task is evaluated from 0 to 5 points, the second - from 0 to 4 points.

- a correctly performed synthesis, a compiled program, a simulation performed by the method of time diagrams meets the condition - 5 (4) points;*

- correctly performed synthesis, compiled program, performed simulation using the time diagram method partially meets the condition - 3-4.9 (3-3.9) points;*

- the synthesis was performed with errors, the program was compiled, the simulation performed by the time diagram method did not meet the condition - 2-2.9 (2-2.9) points;*

- the synthesis was performed with errors, the program was compiled incorrectly or only the synthesis was performed correctly - 1-1.9 (1-1.9) points;*

- the synthesis was made with errors, the program was not completed - 0-0.9 (0-0.9) points.*

** in parentheses is the assessment for task 2.*

In task 1, it is necessary to perform logic synthesis using the graph transition method on JK - or RS -triggers according to the given cycle diagram, build a circuit in the Quartus II environment and make a visualization using the time diagram method. In task 2, it is necessary to carry out a synthesis on multiplexers with two (or three) selector lines according to the given Carnot map , build a circuit in the Quartus II environment and perform a simulation using the timing diagram method.

Calendar control

Calendar control is based on the current rating. A condition for a positive assessment is the value of the student's current rating of at least 50% of the maximum possible at the time of assessment. The score required to obtain a positive calendar control is made known to the students by the teacher no later than 2 weeks before the start of the calendar control.

Additional (bonus) points

The rating system provides additional points for completing additional tasks. One student cannot receive more than 10 bonus points in a semester. Bonus points can be obtained for the following types of work: " Events ", "Additional lectures".

Events

Events are special events for students who want to get extra points for solving difficult tasks. Events are activated at a specified time (usually Monday) and are active for one week (until the following Monday). Additional points are awarded only to those students who correctly completed the tasks and uploaded their answers within the time limit set by the event . The number of points for additional tasks is determined by each event separately. One student cannot receive more than 5 bonus points for events .

Additional lectures

Additional lectures are topics for independent study, which will provide students with a strengthening of theoretical knowledge of the discipline. ***Weight score 0.5.*** *One student cannot receive more than 5 bonus points for additional lectures.*

Winners receive points for uploading a synopsis of the prepared lecture to the Moodle system .

The form of semester control is an exam

The maximum number of points for work in the semester is 60. A necessary condition for admission to the exam is completed and defended laboratory work, completed tasks for practical classes, a semester rating of at least 30 points.

The exam includes two components: theoretical and practical. ***The theoretical component*** *is aimed at checking students' knowledge acquired as a result of studying the educational component in the form of testing based on the lecture material of the semester. Each test contains 20 questions of different formats (choosing the correct option from the list; true/false; matching; numerical answer; choosing the missing words; dragging on the picture, etc.). The maximum number of points for testing is 20 questions * 1 point = 20 points.* ***The practical component*** *involves checking the acquired skills of students to synthesize, design and check according to the conditions of the task of developing automation systems. Each student is given a separate task, according to the conditions of which it is necessary to perform a synthesis, compile a program in the CoDeSys environment , perform a simulation and make a visualization. The maximum number of points per problem is 20 points.*

Evaluation criteria of the theoretical component

- *questions such as "choosing the correct option from the list", "true/false", "numerical answer" are evaluated unambiguously: a correct answer - 1 point, an incorrect answer - 0 points;*
- *questions that do not have one specific answer, such as "determine the correspondence", "select the missing words", "drag to the image" are evaluated according to the number of elements in the test (for example, if you need to insert 4 words into the text, then the student will receive 0 .25 points for one correctly inserted word, and for all 4 correctly inserted words he will receive 1 point respectively) - incorrect answer - 0 points, partially correct answer - 0.1-0.9 points, correct answer 1 point.*

Evaluation criteria of the practical component

- correctly performed synthesis, compiled program, performed simulation meets the condition, performed visualization - 20 points;

- the synthesis is correctly performed, the program is compiled, the simulation performed partially meets the condition, the visualization is partially done - 15-19 points;

- the synthesis was performed with errors, the compiled program did not meet the condition, the visualization was not done - 10-14 points;

- the synthesis was performed with errors, the program was compiled incorrectly or only the synthesis was performed correctly - 5-9 points;

- the synthesis was made with errors, the program was not completed - 0-4 points.

Working program of the academic discipline (syllabus):

Compiled by an associate professor of the Department of Automation of Electromechanical Systems and Electric Drives of the FEA , Ph.D. Buryan S.O.

Approved by the Department of Automation of Electromechanical Systems and Electric Drives of the FEA (Protocol No. 15 dated 13.06.2024)

Agreed by the Methodical Commission of the faculty (protocol No. 10 dated 06/20/2024)