National Technical University of Ukraine
Igor Sikorsky Kyiv Polytechnic Institute "

Department of Electromechanical Systems Automation and Electrical Drives

AUTOMATION SYSTEMS. COURSEWORK

Working program of the academic discipline (Syllabus)

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	*Full-time (day, accelerated day)*
Year of training, semester	*3rd year, spring semester (full-time)* *2nd year, spring semester (full-time accelerated)*
Scope of the discipline	*45 hours / 1.5 ECTS credits*
Semester control/ control measures	*Test*
Class schedule	*Consultations on a separate schedule (not shown in the schedule)*
Language of teaching	*Ukrainian*
Information about the head of the course / teachers	Project leader : *Ph.D. , associate professor Serhii Oleksandrovych Buryan , 0508403155*
Placement of the course	https://do.ipo.kpi.ua/course/view.php?id=1769

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. The course project " 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 students' following competencies: (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-cycle automation schemes, which are used in their technical implementation in the form of control algorithms for programmable logic integrated circuits.*

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 "Computer technology and programming", "Engineering graphics", "Synthesis of logical circuits" and "Automation systems. Part 1". Competences, knowledge and skills obtained 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

Discipline "Automation systems. The course project" consists of the following stages :

Issuance of an assignment for a course project.

Chapter 1. Analytical overview of the field of use of FPGA.

Chapter 2. Formulation of the task for the course project and its detailing.

Chapter 3. Development of the functional scheme of the control system and determination of all its signals.

Chapter 4. Synthesis of logical functions and control algorithms.

Chapter 5. Selection of electrical equipment and FPGA.

Chapter 6. Development of a FPGA program in the Quartus II environment in the FBD/ Verilog language HDL .

Chapter 7. Visualization of the program in the Quartus II environment.

Chapter 8. Development of power supply units.

Chapter 9. Development of an electrical principle diagram in the environment of Dip Trace and list of elements to the scheme.

Submission of the completed course project and graphic part for verification.

Protection of the course project.

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 1 [Electronic resource]: study guide for bachelor's degree holders in 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; edited by: S. O. Buryan, G. Yu. Zemlyanukhina , R. S. Volyanskyi . – Electronic text data (1 file: 7.56 MB). – Kyiv: KPI named after Igor Sikorskyi, 2022. – 255 p. – Name from the screen (access via the link https://ela.kpi.ua/handle/123456789/48594).

3. 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).

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

5. Design of computer systems based on microcircuits of programmable logic [Text]: monograph / S.A. Ivanets, Yu.O. Zuban , V.V. Kazimir, V.V. Litvinov. - Sumy: Sumy State University , 2013. - 313 p. (access via the link http://essuir.sumdu.edu.ua/handle/123456789/33465).

6. V. Ya. Semenyuk Classification of modern programmable logic integrated circuits / V. Ya. Semenyuk, M. V. Voskresenskyi, O. I. Miskevich . // Scientific journal "Computer-integrated technologies: education, science, production". – 2013. – No. 12. – pp. 180–183. (access via https://cutt.ly/OOoJhE3) .

7. Altera Cyclone II. Device Family Overview (access by link https://cutt.ly/1OoJbm4).

8. Altera MAX300A. Programmable Logic Device Family (access via the link https://cutt.ly/KJUTy6e).

9. Intel Max 10 GPGAs Device Overview (access via the link https://cutt.ly/AOoLKxT).

10. Intel DE10-Lite Board. Documentation (access via the link https://cutt.ly/WOoZUqH).

Additional literature

11. Bruno, F. (2021). FPGA Programming for Beginners. Packt Publishing Ltd, Birmingham-Mumbai. ISBN 978-1-78980-541-3.

12. Zeidman, B. (2002). Designing with FPGAs and CPLDs. Elsevier, CMP Books Lawrence, Kansas. ISBN: 1-57820-112-8.

13. Grout, I. (2008). Digital Systems Design with FPGA and CPLD. Elsevier. ISBN-13: 978-0-7506-8397-5.

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

15. Darren Ashby and others (2008). Circuit Design. Elsevier. ISBN: 978-1-85617-527-2.

16. Intel DE1-SoC Board. Documentation (access via the link https://cutt.ly/JOoC6PI).

17. Brock J. LaMeres (2017). Introduction to Logic Circuits & Logic Design with VHDL. Springer . ISBN 978-3-319-34194-1 .

18. Valery Sklyarov , Iouliia Skliarova , Alexander Barkalov , Larysa Titarenko (2014). Synthesis and Optimization of FPGA-Based Systems. Springer . DOI 10.1007/978-3-319-04708-9

19. Jivan S. Parab , Rajendra S. Gad , GM Naik (2018). Hands-on Experience with Altera FPGA Development Boards. Springer . DOI 10.1007/978-81-322-3769-3.

Educational content

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

Each student has the right to choose one of the three topics and the appropriate option for this topic. The following topics are available to students:*

Topic 1. Automation systems of the power head and rotary table of the aggregate machine.

Topic 2. Industrial conveyor automation system with manipulator robots.

Topic 3. Car wash automation system.

Topic 4. Warehouse automation system.

Options for the respective topics differ in complexity:

- *options without an asterisk are intended for students who want to get a maximum score of no more than 84, provided that all stages of the course project are completed and it is successfully defended;*
- *options marked with an asterisk (*) are intended for students who want to get a maximum score of no more than 94, provided that all stages of the course project are completed and its successful defense;*
- *the options marked with two asterisks (**) are intended for students who want to receive 100 points, provided that they complete all stages of the course project and successfully defend it.*

Before starting the course project, students must fill out the assignment form and upload it to the appropriate section of the distance course. Downloading the completed form by the student is considered to be his receipt of the option and assignment for the course project.

In the course of the course project, according to the calendar schedule, students must download the relevant sections of the course project for verification in the distance course.

Every week, the teacher holds a consultation where students can ask questions about the current section of the course project. At the same consultation, at the request of the students, the teacher can check completed sections of the project.

**** At the student's request, he can take an individual topic with the development of an automation system of an arbitrary industrial object , upon agreement of this topic and initial data with the teacher.***

6. Student's independent work

No	*Type of independent work*	*Number hours of SRS*
1	Obtaining a topic and an option for a course project	1
2	Implementation of Section 1. Analytical overview of the field of use of FPGA	4
3	Execution of Section 2. Formulation of the task for the course project and its detailing	3
4	Implementation of Section 3. Development of the functional scheme of the control system and determination of all its signals	2
5	Execution of Section 4. Synthesis of logical functions and control algorithms	8
6	Implementation of Section 5. Selection of electrical equipment and FPGA	2
7	Execution of Chapter 6. Development of a FPGA program in the Quartus II environment in the *FBD/ Verilog language HDL*	8
8	Execution of Section 7. Visualization of the program in the Quartus II environment	4
9	Implementation of Section 8. Development of power supply units	4
10	Execution of Section 9. Development of an electrical principle diagram in the environment of Dip Trace and list of elements to the scheme	6
11	Preparation of the course project	2
12	Protection of the course project	1
	In total	**45**

Policy and control

7. Policy of academic discipline (educational component)

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

- *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 for the discipline";

- *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;*
- *students are required to attend consultations on the discipline " Automation systems. Course project ";*
- *students are obliged to regularly review messages in the common Telegram channel, as well as promptly respond to them;*
- *students must timely upload sections of the course project to the appropriate distance course for review.*

Types of control and rating system for evaluating learning outcomes (RSO) in the discipline

Current control *: execution of sections according to the calendar plan.*
Calendar control *: carried out twice a semester as a monitoring of the current status of meeting the syllabus requirements.*
Semester control: *assessment.*
Conditions for admission to the semester control *: completed 9 sections of the course project*
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:

- *execution of sections of the course project according to the calendar plan;*
- *the quality of the course project;*
- *defense of the course project.*

Execution of sections according to the calendar plan	*Design quality*	*Protection of the course project*
45	*10*	*45*

Execution of sections according to the calendar plan

Weighted point 5. *The maximum number of points for completing sections of the course project according to the calendar plan – 5 points * 9 sections = 45 points.*

Calendar plan for the implementation of sections of the course project

Control dates	The name of the stage of work	Maximum score
12.02.2024	Issuance of an assignment for a course project	-
02/26/2024	Chapter 1. Analytical overview of the field of use of FPGA	5
11.03.2024	Chapter 2. Formulation of the task for the course project and its detailing	5
18.03.2024	Chapter 3. Development of the functional scheme of the control system and determination of all its signals	5
04/01/2024	Chapter 4. Synthesis of logic functions and control algorithms	5
04/18/2024	Chapter 5. Selection of electrical equipment and FPGA	5

04/29/2024	Chapter 6. Development of a FPGA program in the Quartus II environment in the *FBD/ Verilog language HDL*	5
04/29/2024	Chapter 7. Visualization of the program in the Quartus II environment	5
05/06/2024	Chapter 8. Development of power supply units	5
05/20/2024	Chapter 9. Development of an electrical principle diagram in the environment of Dip Trace and list of elements to the scheme	5
until 27.05.2024	Submission of the completed course project and graphic part	10
until 10.06.2024	Protection of the course project	25-40*

**Depending on the difficulty of the selected difficulty option*

The calendar plan for the implementation of the sections of the course project and the variant is issued to students in the first week and is sealed with the signature of the student and the teacher. Signed calendar plans are uploaded to the appropriate section of Moodle .

At consultations according to the calendar plan:

- *the presence of a completed section is checked;*
- *the correctness of the applied methods, calculations, etc. is analyzed;*
- *modernity of decisions made.*

Evaluation criteria

1. Execution of sections according to the calendar plan.

1.1 Timely execution of sections:

- the section of the course project was completed on time, the content of the section corresponds to its essence, the student understands and justifies the decisions made - 5 points;

- the section of the course project was completed on time, the content of the section corresponds to its essence, the student to a certain extent understands and justifies the decisions made - 3-4 points;

- the section of the course project was completed on time, the content of the section corresponds to its essence, the student partially understands and justifies the decisions made - 1-2 points;

- the section of the course project is completed on time, but the content of the section does not correspond to its essence or the student does not understand and cannot justify the decisions made - it is returned for revision.

1.2. Execution of sections with a delay of no more than 1 week:

- the section of the course project was completed no more than 1 week late, the content of the section corresponds to its essence, the student understands and justifies the decisions made - 4 points;

- the section of the course project was completed no more than 1 week late, the content of the section corresponds to its essence, the student to a certain extent understands and justifies the decisions made - 2-3 points;

- the section of the course project was completed no more than 1 week late, the content of the section corresponds to its essence, the student partially understands and justifies the decisions made - 0.5-1 point;

- a section of the course project is completed no more than 1 week late, but the content of the section does not correspond to its essence or the student does not understand and cannot justify the decisions made - it is returned for revision.

1.3. Execution of sections with a delay of more than 1 week:

- the section of the course project was completed more than 1 week late, the content of the section corresponds to its essence, the student understands and justifies the decisions made - 3 points;

- the section of the course project was completed more than 1 week late, the content of the section corresponds to its essence, the student to a certain extent understands and justifies the decisions made - 1-2 points;

- the section of the course project was completed more than 1 week late, the content of the section corresponds to its essence, the student partially understands and justifies the decisions made - 0-0.5 points;

- a section of the course project was completed more than 1 week late, but the content of the section does not correspond to its essence or the student does not understand and cannot justify the decisions made - it is returned for revision.

2. The quality of the design of the course project

- the course project is designed with high quality in compliance with the requirements for the design of technical documentation, the basic electrical scheme is made according to ANSI requirements and does not contain defects - 9-10 points;

- the course project is designed with high quality in compliance with the requirements for the design of technical documentation, but it contains minor comments, the basic electrical diagram is made according to ANSI requirements and contains minor flaws - 6-8 points;

- the course project is designed mainly in compliance with the requirements for the design of technical documentation, contains comments, the electrical schematic diagram is made mainly according to ANSI requirements and contains shortcomings - 1-5 points;

- the course project is designed with significant flaws, contains remarks, the basic electrical scheme is not made according to ANSI requirements - it is returned for revision and is evaluated at 0 points.

3. Protection of the course project.

Quartus software II questions are asked to understand the operation of its automation system, synthesized algorithms, modes of operation, schemes, etc. In accordance with the received answers, the teacher assigns from 0 to 40 points for the defense, according to the level of received answers to the questions.

Additional (bonus) points

The rating system provides additional points for innovative ideas and methods of solving the tasks of individual sections of the course project. One student cannot receive more than 10 bonus points in a semester. The amount of additional points is determined separately for each student depending on the level of innovation.

The form of semester control is credit.

The maximum number of points is 100. A necessary condition for admission to credit is a protected course project. The corresponding grade is published after the defense of the course project, provided that the student has scored at least 60 points.

Students who defended the course project, but received a rating of less than 60 points, receive additional assignments on their course project to increase the grade (up to 60 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)