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Національний технічний університет України
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені ІГОРЯ СІКОРСЬКОГО»

of Electromechanical Systems and Electric Drive FEA

Control and automation of technical systems

Work program of the discipline (Syllabus)

Details of the discipline	
Level of higher education	***Second (educational and scientific)***
Branch of knowledge	*14 "Electrical Engineering"*
Specialty	*141 "Electric power, electrical engineering and electromechanics"*
Educational program	*ELECTRIC POWER ENGINEERING, ELECTRICAL ENGINEERING AND ELECTROMECHANICS*
Discipline status	*Normative*
Form of study	*Eye (day)*
Year of preparation, semester	*1st course, the autumn semester*
The scope of discipline	*180 hours / 6 ECTS credits*
Semester control / control measures	*Exam / MCR*
Timetable	*http://rozklad.kpi.ua*
Language of instruction	*Ukrainian / English*
Information about the course leader / teachers	Lecturer:*Ph.D. Korol Serhii Viktorovich, 0981708081* Practical:*Ph.D. Korol Serhii Viktorovich, 0981708081*
Course placement	https://classroom.google.com/u/0/c/MTQ2MzQ4ODExOTMy?hl=en

Curriculum

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

The program of the discipline "Control and automation of technical systems" is made according to the educational program "Electric power, electrical engineering and electromechanics" of preparation of the doctor of philosophy of a specialty 141 - Electric power, electric engineering and electromechanics.

The purpose of the discipline *there is a formation in students of the following abilities:*
perform original research, achieve scientific results that create new knowledge in electrical engineering and related interdisciplinary areas and can be published in leading scientific journals in electrical engineering and related fields; orally and in writing to present and discuss the results of research and / or innovative developments in Ukrainian and English, a deep understanding of English-language scientific texts in the field of research; apply modern information technologies, databases and other electronic resources, specialized software in scientific and educational activities; identify, pose and solve research problems in the field of electrical engineering and digital automation, evaluate and ensure the quality of research.

The subject of the discipline - *Subject of the discipline: methods of solving theoretical and practical problems of design, programming and debugging of technical automation systems.*

Program learning outcomes:

Competences:(LC3) the ability to use information and communication technologies; (LC6) the ability to learn and master modern knowledge; (LC7) the ability to identify and assess risks; (FC2) the ability to develop and implement measures to improve the reliability, efficiency and safety in the design and operation of equipment and facilities of electricity, electrical engineering and electromechanics; (FC3) the ability to analyze technical and economic indicators and examination of design decisions in the field of power engineering, electrical engineering and electromechanics; (FC8) Ability to demonstrate awareness and ability to use regulations, norms, rules and standards in power engineering, electrical engineering and electromechanics; (FC9) the ability to use computer simulation software, automated design, automated production and automated development or design of elements of electric power, electrotechnical and electromechanical systems; (FC11) ability to design robust and adaptive control algorithms for electromechanical automation systems and electric drives, to develop optimal and intelligent control laws using identification and observation methods; (FC13) the ability to develop electromechanical vehicle automation systems using the latest environmentally friendly technologies. (FC11) ability to design robust and adaptive control algorithms for electromechanical automation systems and electric drives, to develop optimal and intelligent control laws using identification and observation methods; (FC13) the ability to develop electromechanical vehicle automation systems using the latest environmentally friendly technologies. (FC11) ability to design robust and adaptive control algorithms for electromechanical automation systems and electric drives, to develop optimal and intelligent control laws using identification and observation methods; (FC13) the ability to develop electromechanical vehicle automation systems using the latest environmentally friendly technologies.

Skills:(PH01) to reproduce processes in electric power, electrotechnical and electromechanical systems at their computer modeling; (PH02) to outline the plan of measures for increase of reliability, safety of operation and prolongation of a resource of the electric power, electrotechnical and electromechanical equipment and the corresponding complexes and systems; (PH04) to reconstruct existing electrical networks, stations and substations, electrical and electromechanical complexes and systems in order to increase their reliability, operational efficiency and resource life; (PH06) to search for sources of resource support for additional training, research and innovation; (PH11) to communicate freely orally and in writing in state and foreign languages on modern scientific and technical problems of electric power, electrical engineering and electromechanics; (PH14) to master new versions or new software designed for computer modeling of objects and processes in electrical, electrical and electromechanical systems; (PH15) to synthesize algorithms of robust and adaptive, vector control, tracking and program control of movement.

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

To successfully master the discipline, the student must have a "Foreign language for research", as much of the latest technology is described in the scientific literature in English, and it is desirable to master the disciplines "Computer Science and Programming", "Automatic Control Theory",

"Synthesis of Logic Circuits" , "Automation systems", "Fundamentals of microprocessor technology", "Control of electric drives", "Course work on automation systems". Competences, knowledge and skills acquired in the process of studying the credit module are necessary for the quality of research on the topic of the master's thesis.

3. The content of the discipline

The discipline is structurally divided into 4 sections, namely:

Section 1. PROGRAMMED LOGICAL CONTROLLERS

Topic 1.1. General Information
Topic 1.2. Inputs and outputs
Topic 1.3. Real time mode
Topic 1.4. Work cycle
Topic 1.5. Reaction time
Topic 1.6. Design features of the controller structure
Topic 1.7. Operating System
Topic 1.8. Environmental protection
Topic 1.9. Entry level controllers
Topic 1.10. Controllers of the lower level of enterprise automation systems
Topic 1.11. Expansion modules
Topic 1.13. Middle level controllers of enterprise automation systems
Topic 1.14. Top level controllers of enterprise automation systems
Topic 1.15. International Electrotechnical Commission Standard 61131
Topic 1.16. PLC programming tools

Section 2. TYPES OF DATA AND VARIABLES

Topic 2.1. The main categories of data types
Topic 2.2. Numerical data types
Topic 2.3. Specialized types
Topic 2.4. User data types
Topic 2.5. Identifiers and memory allocation of variables
Topic 2.6. Direct addressing
Topic 2.7. Features of calculations
Topic 2.8. Hungarian record

Section 3. MODULES OF PROGRAM ORGANIZATION

Topic 3.1. general information
Topic 3.2. Software module announcement section
Topic 3.3. Functions
Topic 3.4. Functional blocks
Topic 3.5. Instance initialization and features of using functional blocks
Topic 3.6. Programs and features of their work

Section 4. PROGRAM DEVELOPMENT FOR PROGRAMMED LOGICAL CONTROLLERS

Topic 4.1. Expressions
Topic 4.2. Conditional operators
Topic 4.3. Cycle operators

Topic 4.4. Arithmetic and mathematical operators
Topic 4.5. Bit comparison and processing operators
Topic 4.6. Timers
Topic 4.7. Triggers and pulse detectors
Topic 4.8. Counters

4. Training materials and resources

Basic

1. *Petrov IV Programmable controllers. Standard languages and methods of applied design / Ed. Prof., VP Dyakonova. - M .: SOLON-Press. - 2004. - 256 p.*
2. *Elperin IV Industrial controllers: Textbook. The method. - K: Nucht. - 2003. - 320p.*
3. *Demenkov NP Programming languages of industrial controllers: Textbook / Ed. K.A. Pupkova. - M .: Izd-vo MSTU im. N.E. Bauman. - 2004. - 172p.*
4. *Michel J., Lorjo K., Espio BM Programmable controllers. M .: Mechanical Engineering. - 1986. - 176p.*
5. *Karpov Yu. G. Theory of automata. SPb .: Peter. - 2002. - 224 p.*
6. *Control and automation of technical systems - 2. Course project: Methodical instructions for the course project. [Electronic edition]. - 2006. - 42 p.*
7. *Programmable logic controllers: Text of lectures for the direction of training 6.050702 - "Electromechanics", specialties 7.05070204, 8.05070204 - "Electromechanical automation systems and electric drive" full-time / Type. S.V. King. - K .: NTUU "KPI", 2013. - 124 p.*
8. *Programmable logic controllers a practical approach to IEC 61131-3 using Codesys.Doug H. Hanssen- 2015. - 416p. ISBN 9781118949245*
9. *Minaev IG, Samoilenko VV Programmable logic controllers: a practical guide for a novice engineer. Stavropol: AGRUS. - 2009. - 100p.*
10. *Programmable controllers: a guide for the engineer / E. Parr. Per. 3rd English Ed. - M .: BINOM. Knowledge laboratory. - 2007. - 516p.*
11. *Shalyto AA Logical control. Methods of hardware and program implementation of algorithms. SPb .: Nauka. - 2000. - 780 p.*
12. *Baskakov SI Radio circuits and signals. M .: Higher school. - 2000. - 462 p.*
13. *Dyakonov VP Computer mathematics. Theory and practice. M .: Knowledge. - 2001. - 1296 p.*
14. *Programmable controllers: theory and implementation / LA Bryan, EA Bryan. Second edition. - 1997. - 1035p. ISBN 0-944107-32-X.*
15. *Hugh Jack. Automating Manufacturing Systems with PLCs. Version 4.7. - 2005. - 845p.*

Auxiliary:

16. *Michel J. Programmable controllers: architecture and application. M .: Mechanical Engineering. - 1992. - 498p.*
17. *John Karl-Heinz, Tiegelkamp M. IEC 61131-3: Programming Industrial Automation Systems. Concepts and Programming Languages, Requirements for Programming Systems, Decision-Making Tools. Springer-Verlag Berlin Heidelberg, 2001*
18. *Lewis RW, Programming industrial control systems using IEC 1131-3 / Revised ed. The Institution of Electrical Engineers. London, United Kingdom, 1998.*
19. *Monari PD, Bonfatti F., Sampieri U., IEC 1131-3: Programming methodology. Software engineering methods for industrial automated systems., CJ International, France, 1999.*
20. *User Manual for PLC Programming with CoDeSys 2.2, 3S - Smart Software Solutions GmbH. Kempten, 2002.*

21. IEC DIS 1131-3 Programable Controllers - Programming Languages, Draft International Standard, International Electrotechnical Commission. February 14, 1992

22. Besekersky VA, Izrantsev VV Automatic control systems with microcomputers. M .: Science. - 1987. - 320 p.

23. Kahaner D., Mouler K., Nash S. Numerical methods and software. M .: Mir, 2001. - 575 s.

24. Steven W. Smith, The Scientist and Engineer's Guide to Digital Signal Processing., California Technical Publishing, 1997.

25. Structuring Program Development with IEC 61131-3. Eelco van der Wai, Managing Director of PLCopen (www.plcopen.org).

26. MULTIPROG wt Manual, English release 2.0, 1998, Klopper und Wiege Software GmbH.

27. Bernd Pelzer, Realtime Extensions for Windows NT: ProConOS NT - Realtime Software PLC on Windows NT. Klopper und Wiege Software GmbH.

28. OpenPCS Programming System Short Introduction, Version 4.0 English, 2000, Infoteam Software GmbH.

29. SoftControl V2.3 PLC Programming System, Help, Softing GmbH.

30. iCon-L Open Programming System for Industry Automation V3.0, Help, MPS & AT / ProSign GmbH.

31. Programming with STEP 7 V5.0, Release 02, 1999, Siemens AG.

32. Working with STEP 7 V5.0, Release 02, 1999, Siemens AG.

33. G. Frey, L. Litz (Eds.). Formal Methods in PLC Programming IEEE SMC 2000, Nashville, TN, 8-11 October 2000.

34. Konrad Etschberger, Area Area Controller. Basics, Protocols, Chips and Applications, IXXAT Press. Germany, 2001.

35. Simple α2 Application Controller Programming Guide. Manual number: jy992d97101b, Oct., - 2003

36. Phillips C., Harbor R. Feedback control systems. M .: Laboratory of Basic Knowledge, - 2001 - 616 p.

37. Microprocessor System of Technical Means (MTSS). Programming guide. Smolensk: JSC NPO "Technopribor".

38. Norton P., Yao P. Borland C ++ programming in Windows. K .: Dialektika, - 1993.

39. S.V. King Programmable logic controllers-1: Methodical instructions for laboratory works– K .: NTUU «KPI», 2011, - 68 p.

Information resources

40. http://iadt.siemens.ru/assets/files/infocenter/catalogs_and_brochures/as/catalogs/ST70/02_LOGO_2013_ru.pdf

41. http://iadt.siemens.ru/assets/files/infocenter/catalogs_and_brochures/as/catalogs/ST70/03_S7-200_2013_r.pdf

42. http://iadt.siemens.ru/assets/files/infocenter/catalogs_and_brochures/as/catalogs/ST70/05_S7-300_2013_ru_small.pdf

43. http://iadt.siemens.ru/assets/files/infocenter/catalogs_and_brochures/as/catalogs/ST70/06_S7-400_2013_ru.pdf

Educational content

5. Methods of mastering the discipline (educational component)

Lectures

№	The title of the lecture topic and a list of key issues

s / n	(list of teaching aids, links to information sources)
1	Introduction The emergence and main directions of development of automation systems based on microprocessor technology. Advantages, characteristic features of digital automation systems, main sections of the credit module. Section 1. Programmable logic controllers Topic 1.1. Principles of construction of digital automation tools Distributed control systems, purpose and features of construction. Automation systems based on programmable logic controllers (PLC), advantages and disadvantages. Programming languages for PLCs, their characteristics. PC-based automation systems. Their features, advantages and disadvantages. Topic 1.3. Inputs and outputs Assignment of discrete PLC inputs and their characteristics. Purpose of discrete PLC outputs and their characteristics. Purpose of analog PLC inputs and their characteristics. Purpose of analog outputs of PLC and their characteristics. Specialized PLC inputs and outputs. Literature: [1], p. 14-15; with. 17-20; [4], p. 54-59. [2], p. 7-11.
2	Topic 1.3. Inputs and outputs Assignment of discrete PLC inputs and their characteristics. Purpose of discrete PLC outputs and their characteristics. Purpose of analog PLC inputs and their characteristics. Purpose of analog outputs of PLC and their characteristics. Specialized PLC inputs and outputs. Literature: [1], p. 14-15; [4], p. 54-59.
3	Topic 1.4. Real time mode Real-time systems, their types and features. Principles of building real-time systems. Topic 1.5. Work cycle The structure of the operating cycle of the PLC. Scanning systems of what type, their advantages. Distribution of working cycle time and rules for measuring its duration. Work cycle time control function. Topic 1.6. Reaction time PLC reaction time, rules for calculating reaction time. Measures to reduce the reaction time of PLC. Topic 1.7. Design features of the controller structure PLC architecture, advantages and disadvantages of different architectures. PLC layout technologies. Monoblock, modular, distributed, multiprocessor architectures of logic controllers. Mezzanine technology for building controllers. Software controllers. Literature: [1], p. 15-16, 21-27; [2], p. 32-36; [4], p. 41-46.
4	Topic 1.8. Operating System Composition, purpose, main functions of the operating system of logic controllers. Control of length of a working cycle. Topic 1.9. Environmental protection Characteristics of the industrial environment. International standards for the protection of personnel from electric shock and protection of electronic components placed in the middle

	of the device from moisture and dust. Levels of protection against penetration of solid particles. Levels of protection against penetration of liquids. Literature: [1], p. 16-17, 27-28; [2], p. 38-40.
5	*Topic 1.10. Entry level controllers* *Appointment of entry-level controllers, typical representatives of such controllers. Features of entry-level controllers.* *Topic 1.11. Controllers of the lower level of enterprise automation systems* *Appointment of lower level automation controllers. Features of lower level controllers.* *Topic 1.12. Expansion modules* *Expansion modules for lower level controllers of automation systems. Connection of PLC input and output lines. Technical characteristics of input and output lines.* *Topic 1.13. Middle level controllers of enterprise automation systems* *Assignment of controllers of average level of automation. Features of mid-level controllers. Literature: [39], p. 2.2-2.13; [40], p. 3.2-3.19, [41], p. 5.2-5.39.*
6	*Topic 1.14. Top level controllers of enterprise automation systems* *Appointment of controllers of the top level of automation. Features of top level controllers.* *Topic 1.15. International Electrotechnical Commission Standard 61131* *History of origin and purpose of the IEC 61131 standard. Problems solved by the international IEC-61131 standard. The structure of the standard. Brief description of the standard programming languages regulated by the standard.* *Topic 1.16. PLC programming tools* *Functions of specialized programming packages. Overview of universal packages for PLC programming, their main functions and differences. Functionalities of the package, which is planned for the course project on the credit module. Literature: [1], p. 32-44, [2], p. 49-52; [42], p. 6.37-6.75.*
7	*Section 2. Data and variables* *Topic 2.1. The main categories of data types* *General characteristics of data types of the IEC standard, main categories of data types.* *Topic 2.2. Numerical data types* *Integer data types, range of valid values. Integers and data types, ad rules. Valid data types, range of valid values. Rules for using different types of data in the program, compatibility of different data types, implicit data type conversion. Permissible operations, size, examples of use.* *Topic 2.3. Specialized types* *Logical data types, ad rules. Data type for storing the time interval, ad rules. Data type for storing date and time, ad rules. Data type for storing character variables, declaration rules. Hierarchy of types. Permissible operations, examples of use. References: [1], p. 50-57; [3], pp.131-135.*
8	*Topic 2.4. User data types* *Variables such as structure, declaration rules. Variables such as array, declaration rules. Use of arrays in programs for logic controllers, declaration of arrays with data of different types. Creation and rules of using data structures in programs for logic controllers.*

	Topic 2.5. Identifiers and memory allocation of variables *Rules for creating a variable ID. Areas of memory of variables and their purpose. Global, local, input, output, variables and constants. Literature: [1], p. 57-62, p. 64-66.*
9	*Topic 2.6. Direct addressing* *Rules for creating a direct address, areas of direct addressing, types of direct address. Numbering of elements in the field of direct addressing, placement of variables in the memory of the controller. Placement of several variables in one area of memory, and features of direct addressing. Bitwise addressing, data type conversion. Examples of use.* *Application of implicit type conversion, constraints. Type conversion with information loss. Features of work with sign numbers when using additional code. Features of the calculation of the result when the intermediate result exceeds the allowable limits for the resulting variable when performing operations of addition, subtraction and distribution law. Optimization of integer division operations, options for rounding the result. Literature: [1], p. 64-74.*
10	*Topic 2.8. Hungarian record* *The essence of the application of the Hungarian record. Prefixes to denote integer types. Prefixes for types used to store real numbers, time, date, characters. Prefixes for creating identifiers for function blocks, input and output variables, variables of the type created by the user. Advantages of use, rules of creation of identifiers for variables, constants, temporary variables, arrays and structures. Literature: [1], p. 134-153; [2], p. 158-185.*
11	*Section 3. Modules for organizing programs* *Topic 3.1. general information* *Assignment of program organization modules and their main types. Procedure for creating components in CoDeSys. General characteristics of program organization modules.* *Topic 3.2. Software module announcement section* *The structure of the section of the announcement of software modules. Interface of software modules, formal and actual parameters of the module, local, input and output variables of the module. Literature: [1], p. 78-82, [3], p. 10-17.*
12	*Topic 3.3. Functions* *Functions, basic properties. Ways to call functions. Dynamic extension of functions, symbolic form of representation of functions. Features of work of functions with global variables, use of logical functions. An example of a multiplexer function.* *Topic 3.4. Functional blocks* *Functional blocks, basic properties. Copy of the functional block, rules of creation and use. Access to input and output formal parameters of the instance. Calling an instance of a function block, initializing function blocks. Literature: [1], p. 82-94.*
13	*Topic 3.5. Instance initialization and features of using functional blocks* *Initialization of instances of functional blocks. Complex initialization and copying of instances of functional blocks. Features of application of functional blocks at direct addressing and at use of global variables. An example of a function block that implements synchronous output switching. Addition of functional blocks by actions, rules of application of actions. Literature: [1], p. 94-100.*

14	*Topic 3.6. Programs and features of their work* *Definition of organizational module type program, differences from other organizational modules. Program structure. Application of tasks for the organization of work of project programs. Features of software development for PLC, iteration based on the working cycle. Literature: [1], p. 100-103, 133-136; [2], p. 292-295.*
15	*Section 4. Development of programs for programmable logic controllers* *Topic 4.1. Expressions* *Rules for writing mathematical and logical expressions in STL. The order of operations in expressions.* *Topic 4.2. Operators conditions* *Syntax, and an example of using the conditional operator "IF". Syntax, and an example of using the conditional operator "CASE".* *Topic 4.3. Cycle operators* *Syntax and example of using the WHILE loop operator. Syntax, and an example of using the loop operator "REPEAT". Syntax, and an example of using the "FOR" loop operator. Iterations based on the duty cycle. EXIT and RETURN loop interrupt operators are application features. Literature: [1], p. 124-132; [2], p. 286-289.*
16	*Topic 4.4. Arithmetic and mathematical operators* *Symbolic form of arithmetic operators. Mathematical functions examples of use. Operators of choice, or restriction.* *Topic 4.5. Bit comparison and processing operators* *Bit comparison and processing operators, application examples. Logical bit operators. Literature: [1], p. 170-177; [2], p. 289-292.*
17	*Topic 3.6.* Timers *Pulse generator, the purpose of inputs and outputs, the principle of operation. Timer with a delay of switching off, purpose of inputs and outputs, the principle of work. Timer with switch-on delay, assignment of inputs and outputs, principle of operation.* *Topic 4.7. Triggers and pulse detectors* *Triggers, types, purpose of inputs and outputs. Triggers, working principle. Pulse detectors, types of inputs and outputs. Pulse detectors, principle of operation. Literature: [1], p. 178-184; [2], p. 295-299.*
18	*Topic 4.8. Counters* *Assignment of inputs and outputs, the principle of operation of incremental, decremental and incremental-decremental meters. Examples of their use in FBD and ST languages. Literature: [1], p. 170-177; [2], p. 289-292.*

Practical training

№ s / n	*The name of the topic of the lesson and a list of main questions*
1	*Development of terms of reference for the design of automation systems.*
2	*Design of the functional scheme of the automation program.*

3	. Development of algorithm and logical synthesis of control functions for process automation.
4	Selection of element base.
5	Design of the scheme of connections of a control cabinet.
6	Writing a program for the implementation of the developed automation system based on a programmable logic controller.
7	Testing of the developed automation program for the programmable logic controller.
8	Registration of technical documentation of the automation project.
9	Modular control work.

Laboratory classes

№ s / n	Name of laboratory work	Number aud. hours
1	Acquaintance with laboratory stands, rules of safe work with them and with the order of preparation, performance and protection of laboratory works.	2
2	Automation of the coal loading complex in the Codesys software package.	4
3	Development and research of automation systems for the production of ceramic tiles based on Easy 700.	4
4	Implementation of automation systems based on the Alfa controller.	4
5	Development and debugging of the industrial controller program by means of the built-in interface.	4

6. Independent work of student

№з / п	Type of independent work	Number hours of IWS
1	Preparation for classroom classes	36
2	Preparation for laboratory work	32
3	Preparation for MCR	10
4	Exam preparation	30

Policy and control

7. Course policy (educational component)

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

- *rules of attendance: in accordance with Order 1-273 of 14.09.2020, it is prohibited to assess the presence or absence of the applicant in the classroom, including the accrual 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 conduct in the classroom: the student has the opportunity to receive points for the relevant types of educational activities in lectures and practical classes provided by the RSO 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 under the guidance of the teacher;

- *rules of defense of individual tasks: defense of the abstract on the discipline is carried out individually in the form of a presentation to the audience at the last practical lesson;*
- *policy of deadlines and rearrangements: if the student did not pass or did not appear at the MCR (without good reason), his result is estimated at 0 points. Interpretation of MCR results is not provided;*
- *Academic Integrity Policy: 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 conduct of persons and provides a policy of academic integrity for people who work and study at the university, which they should be guided in their activities, including the study and preparation of control measures in the discipline "Advanced technologies in electric drive and electromechanical systems-1";*
- *when using digital means of communication with the teacher (mobile communication, e-mail, correspondence on forums and social networks, etc.) it is necessary to adhere to generally accepted ethical norms, in particular to be polite and limit communication during the teacher's working hours.*

8. Types of control and rating system for evaluation of learning outcomes (RSO)

Current control*: express survey, MCR, work in practical and laboratory classes.*
Calendar control*: is conducted twice a semester as a monitoring of the current state of compliance with the requirements of the syllabus.*
Semester control: *examination.*
Conditions of admission to semester control*: semester rating more than 25 points.*
Table of correspondence of rating points to grades on the university scale:

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

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

- *answers during express surveys at lectures;*
- *conducting research in practical classes;*
- *conducting research in laboratory work;*
- *performing modular control work (MCR)*
- *examination.*

Express survey	*Work on practical classes*	*Work in the laboratory*	*MCR*	*Examination*
9	*18*	*16*	*7*	*50*

Answers during express surveys at lectures

Weight score 1.
Maximum number of points in all lectures -
*1 point * 9 = 9 points.*

Evaluation criteria

- *correct answers to some questions from the place - 1;*

Work on practical classes

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

Evaluation criteria

- *independent problem solving, free possession of the topic of the lesson - 2;*
- *problem solving with the help of a teacher, mastery of individual sections of the topic of the lesson - 1;*

Work on laboratory works.

The weight score is 4. The maximum number of points for 4 laboratory works is 4x4 = 16 points.
Scoring for one laboratory work:

A) Execution:	
- full and timely performance of work	*2*
- incomplete efficiency of the developed program	*1*
- working off missed without good reason and work performed less than 50%	*0.5*
- fine for failure of work equipment	*4*
- fine for delay or violation of order	*1*
B) Protection:	
- defense of the report at the next lesson	*2*
- untimely defense of the report in the semester	*1*
- untimely defense of the report after the end of the semester	*0*

Modular control*.*

The weight score is 7. The maximum number of points for 1 test is 7 points.
Scoring for one test:

-complete answer (not less than 90% of the required information)	*7*
-sufficiently complete answer (not less than 75% of the required information)	*4-6*
-incomplete answer (not less than 60% of the required information)	*2-3*
-unatisfactory answer (less than 60% of the required information)	*0*
-appearance without good reason	

Answer the exam.

At the exam, students perform a written test. Each task contains two questions, which are evaluated in 25 points. The maximum number of points for the exam is 25x2 = 50 points.
Examination evaluation system:

complete answer (not less than 90% of the required information)	*20..25*
sufficiently complete answer (not less than 75% of the required information)	*15..20*
incomplete answer (not less than 60% of the required information)	*8..15*
unsatisfactory answer (less than 60% of required information)	*0*

Conditions for admission to the exam . A necessary condition for admission to the exam is the enrollment of modular tests, lectures and laboratory work, as well as a starting rating of at least 50% of the PC, ie 25 points.

9. Additional information on the discipline (educational component)

Certificates of distance or online courses on the subject can be credited subject to compliance with the requirements set out in Order № 7-177 of 01.10.2020 On approval of the provisions on

recognition in the KPI. Igor Sikorsky learning outcomes acquired in non-formal / informal education

Work program of the discipline (syllabus):

Folded Associate Professor of Automation of Electromechanical Systems and Electric Drive FEA, Ph.D. Korol S.V.

Approved Department of Automation of Electromechanical Systems and Electric Drive FEA (protocol № ___ dated _____2021)

Agreed Methodical commission of the faculty[1] (protocol № __ of _____)

[1]Methodical council of the university - for general university disciplines.