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

Department of Automation of Electromechanical Systems and Electric Drive FEA

Integrated automation 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 spring semester*
The scope of discipline	*150 hours / 5 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 ich, 0981708081*
Course placement	https://classroom.google.com/u/0/c/MTUxNTE2MTgyODA4?hl=en

Curriculum

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

The curriculum of the discipline "Integrated Automation Systems" is compiled in accordance with the educational program "Power Engineering, Electrical Engineering and Electromechanics" training doctor of philosophy specialty 141 - Power Engineering, Electrical 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 engineering problems of design, programming and debugging of distributed automation systems.*

Program learning outcomes:

Competences:(LC3) the ability to use information and communication technologies; (LC6) the ability to learn and master modern knowledge; (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 software for computer simulation, computer-aided design, 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;

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 "Control and automation of technical systems", "Course project on control and automation of technical systems" , "Computing and programming", "Theory of automatic control", "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 2 sections, namely:

Section 1. Industrial networks

Topic 1.1. General characteristics of industrial networks
Topic 1.2. Classification by data recovery time
Topic 1.3. Classification of data transmission methods
Topic 1.4. Basics of configuring the Profibus network
Topic 1.5. Configuring the Profibus Master and Slave network
Topic 1.6. Basics of CAN network configuration
Topic 1.7. Configuring the master and slave in the CAN network
Topic 1.8. Configure process data messages
Topic 1.9. Industrial networks, characteristics, standardization
Topic 1.11. TCP transport protocol and TCP / IP model
Topic 1.11. Network topologies

Topic 1.12. Physical data transmission interfaces, their comparison
Topic 1.13. Network segmentation, ancillary equipment

Section 2. Integration technologies in the process control system

Topic 2.1. The structure of the control system. Rules for the development of control systems.
Topic 2.2. Technologies of interaction of software and hardware in the process control system.
Topic 2.3. Varieties of OPC. Real-time operating systems.
Topic 2.4. Distribution of surveillance and control systems
Topic 2.5. Human-machine interface in integrated systems
Topic 2.6. Review of communication protocols

4. Training materials and resources

Basic

1. Industrial networks and integration technologies in automated systems: [textbook. aid.] / Pupena OM [etc.] - K .: Published by "Lira-K", 2011. - 552 p.

2. Hugh Jack. Integration and Automation of Manufacturing Systems [Electronic resource] / Hugh Jack. 2007, - 593 p. - Access mode:jackh@gvsu.edu.

3. Designing of automation systems [Text]: textbook. manual / MS Pushkar, S.M. Protsenko - D .: National Mining University, 2013. - 268 p.

4. Zurawski, Richard. The industrial communication technology handbook / Richard Zurawski, editor. p. cm. - (The industrial information technology series): CRC Press, Taylor & Francis Group. 2005. - 879 p. [ISBN 0-8493-3077-7.]

5. Integrated process control systems: [textbook. aid.] / Kharazov VG, - Sp-b. : изд-во "Профессия", 2009. - 592 с.

6. Tannenbaum, Andrew. Computer networks. 3rd ed. / Tanenbaum Andrew. - St. Petersburg; Peter, 2002. - 848 pages [ISBN 5-318-00300-1]

7. Tannenbaum, Andrew. Distributed systems. Principles and paradigms / Andrew Tannenbaum, Maarten van Steen. - St. Petersburg; Peter, 2003. - 880 pages [ISBN 5- 272-00053-6]

Auxiliary:

8. Денисенко, В.В. Computer control of technological process, experiment, equipment / V.V. Denisenko. - M.: Hot line - Telecom, 2008. - 608 p.

9. Programmable controllers: theory and implementation / LA Bryan, EA Bryan. Second edition. - 1997. - 1035p. ISBN 0-944107-32-X.

10. Petrov IV Programmable controllers. Standard languages and methods of applied design / Ed. Prof., VP Dyakonova. - M .: SOLON-Press. - 2004. - 256 p.

11. Elperin IV Industrial controllers: Textbook. The method. - K: Nucht. - 2003. - 320p.

12. Demenkov NP Programming languages of industrial controllers: Textbook / Ed. K.A. Pupkova. - M .: Izd-vo MSTU im. N.E. Bauman. - 2004. - 172p.

13. Michel J., Lorjo K., Espio BM Programmable controllers. M .: Mechanical Engineering. - 1986. - 176p.

14. Programmable controllers: a guide for the engineer. Parr. Per. 3rd English Ed. - M .: BINOM. Knowledge laboratory. - 2007. - 516p.

15. Dyakonov VP Computer mathematics. Theory and practice. M .: Knowledge. - 2001. - 1296 p.

16. 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

17. Lewis RW, Programming industrial control systems using IEC 1131-3 / Revised ed. The Institution of Electrical Engineers. London, United Kingdom, 1998.

18. .Monari PD, Bonfatti F., Sampieri U., IEC 1131-3: Programming methodology. Software engineering methods for industrial automated systems., CJ International, France, 1999.

19. User Manual for PLC Programming with CoDeSys 2.2, 3S - Smart Software Solutions GmbH. Kempten, 2002.

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

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

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

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

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

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

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

Information resources:

27. Electronic resource. Modbus specifications and implementation instructions "Modbus Specifications and Implementation Guides". Access mode: http://www.modbus.org/specs.php

28. Structuring Program Development with IEC 61131-3. Eelco van der Wai, Managing Director PLCopen (Access mode:www.plcopen.org).

29. FOUNDATION Fieldbus, Technical Review FD-043, version 3.0 [Electronic resource, access mode http://www.fieldbus.org]

30. 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

№ s / n	The title of the lecture topic and a list of key issues (list of teaching aids, links to information sources)
1	Introduction. The main directions of development of integrated automation systems (ISA). Advantages, characteristic features of digital automation systems, main sections of the credit module. General information about ASKTP. Literature: [1, p. 10-12], [1, p. 17-27], [3, p. 14-23].
2	Section 1. Industrial networks. Topic 1.1. General properties of industrial networks ICA purpose, types of integration, purpose of networks, network nodes. Definition, gradation, functions, requirements. Data exchange. Literature: [1, p. 28-30].
3	Topic 1.3. Classification by data recovery time Principles of data recovery, their advantages and disadvantages. Literature: [1, p. 31-32], [4, p. 50-52], [5, p. 257-275], [6, p. 206-208].
4	Topic 1.4. Classification of data transmission methods Principles of data transportation through the network in integrated automation systems, time characteristics of data transmission.

	Topic 1.5. Basics of configuring the Profibus network *PROFIBUS architecture in the context of the OSI model. Basic principles of PROFIBUS DP operation. Cyclical data exchange process. Basic network settings. Literature: [1, p. 32-33], [1, p. 98-101], [1, p. 168-170], [4, p. 47-48].*
5	*Topic 1.6. Configuring the Profibus Master and Slave network* *Network configuration, address space, pauses to coordinate work. Group settings, synchronization of input and output signals of ISA nodes. Literature: [1, p. 278-291].*
6	*Topic 1.7. Basics of CAN network configuration* *Bosh CAN and ISO 11898 protocols. CANOpen architecture in the context of the OSI model. Basic principles of NMT, PDO operation. Methods of PDO transmission. SYNC object. Nodeguard and Heartbeat services. Literature: [1, p. 87-90], [1, p. 329-361].*
7	*Topic 1.8. Configuring the master and slave in the CAN network* *Configuration of network services, types of SDO, configuration control and diagnostics of industrial network nodes. Literature: [1, p. 362-366].*
8	*Topic 1.9. Configure process data messages* *PDO settings, PDO transfer methods. Dictionary of objects. SDO services. Profile system and configuration principles. Literature: [1, p. 369-376].*
9	*Topic 1.10. Industrial networks, characteristics, standardization* *Industrial networks in the context of the OSI model. Principles of network selection for the construction of distributed automation systems. TCP transport protocol and TCP / IP model. Literature: [1, p. 41-46], [1, p. 71-73].*
10	*Topic 1.11. Network topologies* *Topologies of networks such as bus, star, ring, tree. The principle of operation, differences, advantages and disadvantages. Literature: [1, p. 62-64].*
11	*Topic 1.12. Physical data transmission interfaces, their comparison* *Terms. Physical level tasks. Environment and methods for data transmission. Synchronization, character transfer. Standard industrial interfaces. RS-232 interface. RS-422 interface. RS-485 interface. Solve hardware compatibility of devices with different interfaces. Literature: [1, p. 64-66], [1, p. 177-182].*
12	*Topic 1.13. Network segmentation, ancillary equipment* *Purpose of segmentation and basic levels. Interface converters, repeaters, gateways, routers, bridges, etc. Cables for industrial networks. Literature: [1, p. 62-64], [1, p. 66-71].*
13	*Section 2. Integration technologies in the process control system* *Topic 2.1. Basics of ASUTP description* *Construction of functional schemes of automatic control system, coding of devices on schemes, graphic designations. Literature: [3, p. 73-75], [3, p. 92-97],*
14	*Topic 2.2. Technologies of interaction of software and hardware in the process control system* *Prerequisites. Basic specifications. Functions and problems of integration. General overview of standard technologies of interprogram interaction. General concepts and principles of operation of OPC DA. Procedure for access to data (read / write). Organization of remote communication on OPC. Scope of technology. Literature: [1, p. 457-465].*
15	*Topic 2.3. Varieties of OPC. Real-time operating systems.*

	Characteristics of OPC HDA, their main types. Characteristics and scheme of information exchange of OPC UA service. The main types of real-time systems, the response time of a distributed automation system. Literature: [1, p. 466-474].
16	*Topic 2.4. Distribution of surveillance and control systems* *Functional structure of SCADA, functions of surveillance systems, tasks, requirements, areas of application. Literature: [3, p. 192-196].*
17	*Topic 2.5. Human-machine interface in integrated systems* *Principles of construction, the main elements of the human-machine interface. Design principles. Literature: [1, p. 18-20], [2, p. 223-233], [[2, p. 30.1-30.4].*
18	*Topic 2.6. Review of communication protocols* *HART protocol, Modbus, Profinet, wireless protocols. Features, principles of transfer, advantages. Communication architecture for electric drives General approaches to electric drive control using industrial networks. Literature: [1, p. 73-139].*

Laboratory classes

№ s / n	*Name of laboratory work*	*Number aud. hours*
1	*Control of electric drives in automation systems based on MFD-Titan controllers*	*4*
2	*Development of a graphical interface based on MFD-Titan controllers*	*4*
3	*Development of human-machine interface based on PC-based graphics panels.*	*4*
4	*Development of a monitoring and control system in the CLEARSCADA2017 software environment.*	*4*
5	*Development and research of a distributed automation system based on the CAN network.*	*4*
6	*Development and research of a distributed automation system based on the PROFIBUS DP network.*	*4*
7	*Creating a human-machine interface based on the software package Vijeo Designer 6.2*	*4*
8	*Integration of the Schneider Electric electric drive into the automation system using the MODBUS network*	*4*
9	*Distributed automation system based on MODBUS network with ABB electric drive*	*4*

6. Independent work of student

№з / п	*Type of independent work*	*Number hours of IWS*
1	*Preparation for classroom classes*	*7*
2	*Preparation for laboratory work*	*36*
3	*Preparation for MCR*	*5*
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 laboratory classes.*
***Calendar control**: 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	*Estimated graphic work*	*Work in the laboratory*	*MCR*	*Examination*
9	*10*	*27*	*4*	*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 laboratory works.

The weight score is 3. The maximum number of points for 9 laboratory works is 3x9 = 27 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 2
- fine for lateness or disorderly conduct 1
B) Protection:
- defense of the report at the next lesson 1
- untimely defense of the report in the semester 0.5
- untimely defense of the report after the end of the semester 0

Calculated graphic work (RGR).

*The weight score is 10. The maximum number of points is 1 * 16 points. Scoring for one estimated graphic work:*
- "excellent", timely implementation of the points of work, understanding of the presented material, complete answers to questions to the defense - 9-10 points;
- "good", a slight lag from the schedule, understanding of the presented material, complete answers to questions to the defense with some inaccuracies - 6-8 points;
- "satisfactory", significant lag behind the schedule, incomplete answers to questions to the defense - 2-5 points;
- "unsatisfactory", the work was done with a very significant gap and errors - 0 points.
Work schedule:
Week 6 - issuance of a job assignment;
Week 8 - presentation of the first part of homework (4);
Week 10 - presentation of the second part of homework (4);
Week 12 - work defense.
For each week of late submission of the defense of the calculation and graphic work, the score is reduced by 4 points.

Modular control.

The weight score is 4. The maximum number of points for 1 test is 4 points.
Scoring for one test:

-complete answer (not less than 90% of the required information) 4
-sufficiently complete answer (not less than 75% of the required information) 2-3
-incomplete answer (not less than 60% of the required information) 1
-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.