Ministry of Education and Science of Ukraine
National Aerospace University
“Kharkiv Aviation Institute”

Department of Space Technology and Non-Conventional Energy Sources
(No. 402)

"APPROVED"

Guarantor of the educational program
_____Andriy POGUDIN
August 29, 2025

SYLLABUS OF THE MANDATORY COURSE ACADEMIC DISCIPLINE

Information and control systems and complexes unconventional energy installations

Area of knowledge: 14 "Electrical Engineering"

Specialty: 141 "Electrical Power Engineering, Electrical Engineering and Electromechanics"

Educational programs: " Non-Conventional and Renewable Energy Sources "

Level of higher education: first (bachelor's)

Syllabus effective from 01.09.2025

Kharkiv – 2025

Developer:

Senior Lecturer, Department of
Space Technology and Non-Conventional
Energy Sources (No. 402) _____ Kostyantyn V'YAZOVYK

The syllabus of the academic discipline was considered at the meeting of the Department of Space Technology and Non-Conventional Energy Sources

Protocol No. __1__ dated "28" __ August 2025

Acting Head of the Department, Ph.D.,
Associate Professor _____ Yuriy SHEPETOV

Approved by the representative of the students: Olexandr LISIN

_____ _____ _____
(signature) (first name and last name)

1. General information about the teacher

Full name: V’yazovyk Kostyantyn Leonidovych

Position: Senior Lecturer, Department of Space Technology and Non-Conventional Energy Sources

Academic degree: -

Academic title: -

List of courses taught:
“Testing of Non-Traditional Power Plants”
"Information and Control Systems and Complexes of Non-Traditional Power Plants"
“Ecology and Anthropogenic Environmental Impact of Non-Traditional Power Plants”
“Thermal and Nuclear Power Plants”
“Systems for Measuring, Accounting, and Controlling Energy Use”
“Resource and Energy Conservation”
“Technology for the Production of Converters for Non-Conventional Power Plants”

Areas of scientific research:
- Non- Conventional energy sources;
- Alternative energy

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2. Description of the academic discipline

Form of education	Full-time
Semester	**7th**
Language of instruction	Ukrainian
Type of discipline	Compulsory
Course volume: ECTS credits/number of hours	Full-time: 4.5 ECTS credits / 135 hours (64 classroom hours, including: lectures – 32, practical classes – 16; laboratory work-16, independent work – 71)
Types of educational activities	Lectures, practical (seminar) classes, laboratory work, independent work,
Types of control	Continuous assessment, module-based assessment, semester-end assessment – exam
Prerequisites	"Electrical equipment of power plants", "Electrical stations, networks and systems"
Co-requisites	"Wind turbine design"
Post-requisites	"Bachelor's final thesis"

3. Purpose and objectives of the academic discipline, lists of competencies and expected learning outcomes

The purpose of the academic discipline is: provide knowledge about the purpose, functions, characteristics, structure and composition of information management systems (ICS) and complexes, characteristics of ICS components, information processing technologies in ICS, ICS and complex design technologies

The objectives are:

1. Consider the purpose, functions, characteristics, structures and composition of information and management systems (ICS) and complexes.
2. Consider the characteristics of the components of the IC.
3. Consider information processing technologies in the ICS.
4. Consider the technologies for designing ICS and complexes.

Competencies acquired:

Integral competence*:* The ability to solve specialized tasks and solve practical problems during professional activities in the field of electrical power engineering, electrical engineering and electromechanics or in the process of learning, which involves the application of theories and methods of physics and engineering sciences, is characterized by the complexity and uncertainty of conditions.

General Competencies (GC)

After completing this program, the student will be able to:
Ability for abstract thinking, analysis and synthesis.
Ability to apply knowledge in practical situations.

Special competencies:

After completing this program, the student will be able to:
Ability to solve complex specialized tasks and practical problems related to metrology, electrical measurements, operation of automatic control devices, relay protection and automation at non-traditional and renewable energy facilities.

Program learning outcomes:

Know and understand the theoretical foundations of metrology and electrical measurements, the principles of operation of automatic control devices, relay protection and automation, have the skills to perform appropriate measurements and use these devices to solve professional tasks.

Apply application software, microcontrollers, and microprocessor technology to solve practical problems in professional activities.

Solve complex specialized tasks in the design and maintenance of renewable energy facilities.

4. Course content

Content module 1.

"Classification and main components of the ICS"

TOPIC 1. **Introduction to the academic discipline "Information and control systems and complexes of unconventional energy installations."**

Subject of study and objectives of the discipline "Information and control systems and complexes of unconventional energy installations". The need to use information and control systems (ICS) in the energy sector and, in particular, at stations and autonomous facilities with unconventional energy installations.

TOPIC 2. **Basic concepts of information and control systems and complexes. Classification of ICS.**

The main tasks solved by information and control systems (ICS) and complexes of unconventional energy sources (NEU). Reasons for the need to use ICS. The general structure of ICS, the purpose of its components (sensors, information reception and transmission lines, information input and output devices, information processing devices, software (ICS cores, basic, applied), means of interaction with the operator). Signs of ICS classification.

Classification of ICS by structure: with parallel information channels; parallel-sequential action; sequential action; multiplexed (deploying) systems.

Classification of ICs by purpose: measuring systems; automatic control and management systems; technical diagnostics systems.

Classification of ICs by the nature of interaction with the control object: passive, active.

Classification of ICs by the nature of the impact on the control object: according to a rigid program; taking into account the reaction of the object.

TOPIC 3. **Main components of the ICS and their characteristics.**

Cyclic and address modes of operation of switches. Types of switches: contact and contactless. Principles of construction of switches: hardware (step searchers (electromechanical switches), electron-beam switches), circuit (linear, matrix, pyramidal switches, multi-stage switching), digital (multiplexers and demultiplexers, encoders and decoders).

Unifying devices. Problems solved using unifying devices: signal scaling, linearization of analog circuits for obtaining offset voltage and piecewise linear approximation. Digital signal level converters: direct voltage-code conversion using an analog-to-digital converter (ADC), comparison and successive approximation ADCs; voltage-time and voltage-frequency converters, integrating ADCs, Digital-to-analog converters.

Analog and digital comparison devices: zero-elements, comparators, comparison of signals in digital form.

Information output devices. Factors affecting the efficiency of information perception by the operator. Classification of information provided to the operator: operational, statistical, reporting. Display devices, methods for accelerating information search (grouping of parameters: devices with an individual way of displaying information; devices with displaying generalized information; devices with a regulated information flow; Devices with hierarchical information display. Analog and digital indicators.

TOPIC 4. **Cables of ICS information exchange lines and their characteristics.**

Types of cables used for information exchange: coaxial cables (thin and thick), twisted pair, shielded twisted pair, fiber -optic lines. Their characteristics: bandwidth, capacity, noise immunity, etc. Features of the use of a particular cable.

Practical classes: Cables of ICS information exchange lines and their characteristics.

TOPIC 5. **Communication channel and information characteristics.**

General model of a communication channel. Purpose of components of a channel model. Concept of amount of information, signal-to-noise ratio. General concept of coding: cryptographic, redundancy reduction, noise immunity.

Methods of dividing communication channels: in time and frequency, code division of channels. Channel structures with time and frequency division of communication channels. Error of systems with frequency division of channels. Error of systems with time division of channels.

Practical classes: Communication channel and information characteristics.

Content module 2.

Features of organizing information exchange, development and design of ICS

TOPIC 6. **Features of organizing information exchange when working with electrical objects.**

Features of control objects in power engineering. The concept of electromagnetic purity. The use of modulation to reduce redundancy and increase noise immunity, types of modulation (amplitude, frequency, phase, amplitude-pulse, pulse- width).

Parallel and serial data exchange, their features. Synchronous and asynchronous data exchange, their features. Standard protocols for serial data exchange (RS-232, RS-422, RS-485, I^2C, Micro Lan).

TOPIC 7. **Organization of data exchange.**

Methods of organizing information networks: star, ring, their features. Methods of connecting to the communication line: using subscriber equipment, using special connection equipment, direct connection to the line.

Switching methods: synchronous and asynchronous switching, virtual channel and datagram.

Methods of access control in multi-channel information exchange systems: random access; proportional access; priority access; local-priority access.

TOPIC 8. **Synthesis of object control algorithms.**

Fundamentals of algebra of logic. Operations of conjunction, disjunction, inversion, equivalence, exclusive OR. Laws of algebra of logic. Simplification of logical expressions. Description of a discrete control algorithm using truth tables. Synthesis of a logical block using a truth table.

TOPIC 9. **Features of ICS development.**

Tasks that need to be solved when setting a task for designing an IC: determining the nomenclature of controlled parameters; determining the control algorithm; determining the nomenclature of IC commands; determining the composition of the equipment for signal processing, etc. Determining the need for automation and the nomenclature of operations that need to be automated.

The need for galvanic isolation of power and measuring systems. Methods of ensuring electromagnetic purity (filtration, shielding, separation of power and information objects in space).

Practical classes: Features of ICS development

TOPIC 10. **Designing ICS.**

Basic principles of systems analysis in ICS design. Basic conventions regarding decomposition, synthesis and analysis tasks.

Practical classes: ICS design

Topics for independent work

1) General information, indicators, terms and concepts of chemical energy storage devices.
2) Electrochemical energy storage systems.
3) Performance characteristics, use and combination of chemical batteries in EU NDE.
4) Basic calculations of cycling modes of electrochemical batteries for operation in non-renewable energy storage systems.
5) Fuel cells in hydrogen batteries, electrolyzers, regenerative hydrogen plants, hydrogen and oxygen storage.
6) Operational characteristics of electrochemical generators, electrolyzers and accumulators as part of the NDE power plant.
7) General information and operating principle of thermal energy storage devices.
8) Heat storage materials, their characteristics and selection. Operational characteristics of thermal accumulators as part of the NDE EU.
9) General information and operating principle of mechanical energy storage devices.

10) The device and estimated calculations of the main parameters of dynamic mechanical energy storage devices, types of flywheels, their characteristics, examples of use in non-renewable energy storage devices.
11) The device and basics of calculating electrodynamic energy storage devices, examples of use in non-renewable energy storage systems.
12) The use of capacitive batteries in non-renewable energy storage systems. Basic calculations of capacitive non-renewable energy storage systems.
13) Use of inductive NEs in EU NDE. Basic calculations of inductive NEs.

5. Individual assignments

6. Teaching methods

Conducting classroom lectures, practical work, individual consultations (if necessary), independent work of students based on materials published by the department (methodological manuals).

7. Assessment methods

Assessment of students' knowledge is carried out based on the results of current control, module control (exam).

The total number of points that a student can score during current and module tests, as well as during semester tests, is 100.

Provided that the student completes all types of mandatory work (practical, individual assignments, etc.), the total module grade is converted into a semester grade.

8. Assessment criteria and distribution of points received by students

Table 8.1 – Distribution of points received by students

Components of educational work	Points for one lesson (task)	Number of lessons (tasks)	Total points
Content module 1			
Lecture work	1…2	5	5…10
Completion and defense of practical work	2.5...5	2	5...10
Modular control	20…30	1	20…30
Content module 2			
Lecture work	1…2	5	5…10
Completion and defense of practical work	2.5...5	2	5...10
Modular control	20…30	1	20…30
Total per semester			**60…100**

Semester control (exam) is conducted in case the student refuses the points of the current testing and if there is admission to the exam. When taking the semester exam, the student has the opportunity to get a maximum of 100 points.

The exam ticket consists of three theoretical questions. The maximum number of points for the answer to each theoretical question is 33.3 points (total – 100 points).

Criteria for evaluating a student's work during the semester

Required amount of knowledge to receive a positive assessment:

Know the purpose, functions, characteristics, structures and composition of information management systems (ICS) and complexes. Know the characteristics of ICS components, information processing technologies in ICS, and ICS and complex design technologies. Protection and safety of electrical installations

Skills required to obtain a positive assessment:

Be able to develop the structure of an information and control system, select sensors and equipment, create functional and schematic diagrams, build mathematical models of energy processes, analyze the efficiency of systems, conduct measurements and diagnostics, assess the reliability and efficiency of systems, and make technical decisions in real conditions.

Satisfactory (60-74). Have a minimum of knowledge and skills. Complete and defend all practical work. Demonstrate understanding of the basic provisions of the calculation methodology.

Good (75 - 89). Acquire a minimum of knowledge and skills, complete all tasks, defend all practical work and RR within the time specified by the teacher with justification of the decisions made. Demonstrate understanding of most of the provisions of the calculation methodology.

Excellent (90 - 100). Fully know the main and additional material. Know all topics. Be familiar with textbooks and manuals. Complete all tasks, defend all practical work within the time specified by the teacher justifying the decisions made. Demonstrate a high-quality understanding of all provisions of the calculation methodology.

Grading scale: point-based and traditional

Total points	Traditional scale rating	
	Exam, differentiated test	Test
90 – 100	Excellent	Pass
75 – 89	Good	
60 – 74	Satisfactorily	
0 – 59	Unsatisfactorily	Not counted

9. Course Policy

Class attendance. Absence policy. The interactive nature of the course requires mandatory attendance at practical classes. Students who, under certain circumstances, are unable to attend practical classes regularly must agree with the teacher on a schedule for making up missed classes within a week. Individual missed classes must be made up at the next consultation within a week after they were missed. Classes are made up orally in the form of an interview on questions specified in the class plan. In some cases, it is permissible to make up missed classes in writing by completing an individual written assignment.

Compliance with the requirements of academic integrity by students while studying the academic discipline. When studying the academic discipline, students must adhere to generally accepted moral and ethical norms and rules of conduct, as well as the requirements of academic integrity provided for in the Regulations on Academic Integrity of the National Aerospace University "Kharkiv Aviation Institute"

(https://khai.edu/assets/files/polozhennya/polozhennya-pro-akademichnu-dobrochesnist.pdf). It is expected that the work of students will be their original research or reflections. The absence of references to sources used, fabrication of sources, plagiarism, and interference in the work of other students are examples of possible academic misconduct, but are not limited to these. The detection of signs of academic dishonesty in a student's written work is grounds for its rejection by the teacher, regardless of the extent of plagiarism or deception.

Conflict resolution. The order and procedures for resolving conflicts related to corrupt practices, conflicts of interest, various forms of discrimination, sexual harassment, interpersonal relationships and other situations that may arise during training, as well as rules of ethical conduct are regulated by the Code of Ethical Conduct at the National Aerospace University "Kharkiv Aviation Institute" (https://khai.edu/ua/university/normativna-baza/ustanovchi-dokumenti/kodeks-etichnoi-povedinki/).

10. Methodological support

1. Energy storage [Electronic resource]: teaching aid / S. V. Sinchenko. – Kharkiv: National Aerospace University named after M. Ye. Zhukovsky "Kharkiv. Aviation Institute ", 2019. – 111 p.

1 1. Recommended reading

Basic

1. M.D. Koshel, Theoretical foundations of electrochemical power engineering, Dnipropetrovsk: UDCTU, 2002, 430 p.
2. K. V. Bezruchko, N. V. Belan, D. G. Belov, etc., Solar energy systems of spacecraft. Physical and mathematical modeling, edited by S. N. Konyukhov, Kharkiv: Kharkiv Institute of Technology, 2000, 515 p.

Supplementary

1. Kigel, A. G. — Information -management systems of local electric networks (PDF)

12. Information resources

1. Babak , V., Isaienko , V., & Zaporozhets , A. (Eds .). (2020). Systems , Decision and Control in Energy I. Springer . https://doi.org/10.1007/978 -3 -030 -48583 -2
2. Zaporozhets , A., & Artemchuk , V. (Eds .). (2021). Systems , Decision and Control in Energy II. Springer . https://doi.org/10.1007/978 -3 -030 -69189 -9
3. https://elibrary.kubg.edu.ua/id/eprint/50402/1/S_Kozhemiakina_O_Marukhlenko_Al_in_Bisiness_2024_FEU.pdf
4. https://content.e-bookshelf.de/media/reading/L-10461777-6c95c358a5.pdf
5. Scientific journal " Information and Management " systems » https://www.i-us.ru/jour/issue/archive
6. RTSoft - Information and management systems for the energy industry http://rtsoft.info/project-cards/iuse/
7. Requirements for information and control systems for electrical networks http://irbis-nbuv.gov.ua/cgi-bin/irbis_nbuv/cgiirbis_64.exe?C21COM=2&I21DBN=UJRN&P21DBN=UJRN&IMAGE_FILE_DOWNLOAD=1&Image_file_name=PDF/znpngu_2013_40_15.pdf
8. Informational systems, mechanics and management http://ismc.kpi.ua/issue/archive
9. Adaptive automatic control systems http://asac.kpi.ua/issue/archive