TECHNOLOGIES OF AKUMULATION AND MANEUVERING INPOWER SYSTEMS

SYLLABUS

Cipher and specialty name	141 -"Electric power engineering, electrical engineering, and electromechanics"	**Institute / Faculty**	**NI energy, electronics and electromechanics**
Program Name	Electric power engineering, electrical engineering, and electromechanics	**Department**	Electric stations
Program Type	**professional**	**Language of study**	**English**

Teacher

Andrei Ivakhnov *andrii.ivakhnov@khpi.edu.ua*

Assistant of the Department of Electric Stations. " Author of 13 scientific publications and 2 educational and methodical works. Leading lecturerin the disciplines: "Technologies of storage and modeling in the power system", "Electromagnetic transition processes", "Computer modelingof electric and electromechanical systems",**"Modern technologies of electricity generation".**

General course information

Abstract	The course is aimed at mastering the theoretical bases of modern methods of calculation and modeling of electromagnetic fields of electric power objects
Goals and objectives	**Purpose.** Framing the idea of physical processes occurting in electrical systems when changing the modes of their work; forming the ability to mathematically describe and analyze these processes; forming the skills of using computer technology for modeling and detailed studyof short-circuit currents. **Goals.** • Know and use methods of fundamental sciences to solve general engineering and professional problems • Determine the principles of construction and normal functioning of elements of electric power, electrotechnical electromechanical complexes and systems • Evaluate the parameters of the operation of electrotechnical, electric and electromechanical equipment and the relevant complexes and systems and develop measures to improve their energy efficiency and reliability • Analyze processes in electrical, electrical and electromechanical equipment and related complexes and systems

	• Collect and analyze information about abnormal modes and emergencies in the electrical industry to prevent their recurrence in the future • Possess methods of synthesis of electric power, electrotechnical and electromechanical installations and systems with specified indicators • Evaluate the reliability of the operation of electric power, electrotechnical and electromechanical systems.
Competence	**FC 3 Ability to use basic knowledge in general physics, higher mathematics, theoretical bases of electrical engineering and electrical materials to solve practical problems in** the field of electric power engineering, electrical engineering and electromechanics. **FC 6 Ability to use knowledge on the basics of electromechanics: the theory of electric machines, devices and automated electric drive to solve practical problems in** the field of electricity, electrical engineering and electromechanics. **FC 8 Ability to use modern methods of calculation, modeling and analysis of modes of operation of electric** power, electrotechnical and electromechanical equipment and design of electric and electromechanical systems. **FC 12** Ability to study and analyze scientific and technical information in the field of electricity, electrical engineering and electromechanics. **FC 13** Ability to perform experimental (model) studies of modes of operation of electric power, electrical and electromechanical equipment. **FKS 16 Obtaining and using professional knowledge and understands related to the processes of transmission, distribution of electricity and** electricity in compliance with the specified parameters of technological processes and the quality of electricity.
Format	Scope of discipline: 4 credits ECTS / 120 hours Lectures – 8 hours Independent work – 104 hours Fiveclasses – 2 hours Laboratory works – 2 hours Individual task - abstract Final control - exam
Semester	9th
Controversy	Bachelor's degree training disciplines in the specialty
Post-reclamation	Has no
Teacher requirements	The student is obliged to attend all classes, according to the schedule, not to be late. Adhere to the ethics of behavior. Work with educational and additional literature, with literature on electronic media and on the Internet. When skipping the lecture, an oral interview on the topic is conducted. Practice practical classes with the permission of the teacher. In order to master the necessary quality of education in the discipline, attendance and regular preparation for classes are required.

STRUCTURE OF THE DISCIPLINE

No.	Types of training sessions (L, drugs, CP)	Number of hours	Semester number (if the discipline is taught in several semestra). Names of content modules. Names of topics and questions of each lesson. Tasks for independent work.	Recommended Literature (Base, Secondary)
1.	L1	4	Maneuvering in the electric power network	B 1,4,9-12 D 16
2.	L2	4	Technologies of oculation, their varieties. Lead and alkaline batteries. Lithium batteries	B 2,3,5,8 D 15,18,19
3.	Pr1	2	Report of an individual task. Discussion of conclusions in the group	
4.	LR1	1	Study of the structure of lead and alkaline batteries. Set the battery to charge mode to restore its capacity	Guidelines
5.	Lr2	1	Research of Lithium Batteries	Guidelines
6.		2	Consultation with the teacher	-
7.	WED	104	Independent work	B, D
8.		2	Exam	
Together		16		

INDEPENDENT WORK

№ S/p	Name of types of independent work	Number of hours
1	Processing of lecture material	16
2	Preparation for practical classes	8
3	Performing an individual task:	80
	Together	104

INDIVIDUAL TASKS

ABSTRACT

(type of individual task)

№ S/p	Name of the individual task and/or its sections	Deadlines (in what week)
1	Abstract on a given topic. The student should understand in depth on the topic of the abstract: 1) To investigate the relevance of the issue; 2) Give the basic principles of operation of the devices specified in the topic; 3) Give examples of the use of existing (if any) devices specified in the topic; 4) To independently conclude the expediency of using the devices specified in the topic, with the indication of advantages and disadvantages; 5) At the end, issue, according to the VAC, the list of used sources of information The work is presented in the form of an explanatory note on 10-30 pages: 1) Cover sheet; 2) Table of contents; 3) List of conditional designations and abbreviations; 4) Introduction; 5) The main part; 6) Conclusions; 7) List of sources of information.	10

TEACHING METHODS

The course is focused on the formation of students' ideas about technologies of storage and maneuvering in the power system of Ukraine and other countries, the formation of the ability to describe and analyze these technologies and devices, instill in students the skills of modeling and the use of computer technology in the study and calculations of technologies of storage and maneuvering.

Problematic method and reproductive teaching methods are used with reliance on active teaching methods. The wording of the problem by the teacher and its gradual solution are envisaged.

The main recommendation is to ensure uniform active work of students on the course during the academic semester. They must produce the material of listened lectures, master specialized software, prepare for practical classes to solve problems, perform individual tasks.

Most of the tasks for practical classes involves the presence of an individual task. Instructive-practical and problematic teaching methods are used.

Independent work of the student involves an incentive method of study. It includes the study of lecture material, preparation for practical classes, the implementation of an individual task, the study of additional material. To prepare for practical classes, you should use lecture materials and recommended literature, reference information for the user of applied software, scientific publications in the field of individual assignment.

CONTROL METHODS

The current control is implemented in the form of modular control works and the implementation of an individual task, final examination work.

All lectures of the discipline end with repetition questions to answer. Practical classes involve solving problems. Control is carried out during the survey at lectures, conducting practical classes, protecting the individual task, the current control of the content modules. The assessment takes into account the knowledge of theoretical material, the scope of study of additional literature,

the completeness of answers to control questions and the correctness of the individual practical task.

Control of the component of the work program, which is mastered during the independent work of the student, is carried out:

- from lecture material – by modular control works;
- individual tasks – by evaluating an individual task, protecting it and participating in practical classes.

Final control – exam. (with an assessment on a 100-point scale) in the amount of educational material determined by the curriculum and within the terms established by the curriculum and schedule of the educational process.

The priority is the rating assessment based on the results of the current control and the success of the individual task.

List ofquestions for preparing for the exam:

- The concept of balance in the electric power system, to give all components.
- The concept of maneuvering in the electric power system, to give maneuvering characteristics of different types of power plants.
- Shunting capabilities of TPP and NPP, to give similar and distinctive features.
- The shunting capabilities of the hydroelectric power complex and the GTU bring similar and distinctive features.
- Features of GTU.
- Types of storage technologies.
- Mechanical drives of electricity.
- Electrochemical power storages.
- Electromagnetic power drives.
- Principles of hybrid combination of electricity storages.
- The use of electricity storages in the power system.
- Causes of balance violation in the electricity system.

Criteria for assessing the quality of students' knowledge:

Excellent evaluate student, who deeply and reliably assimilated software material, exhaustive, consistent, competent and logical coherently laid it out, in response linked the theory with practice, showed familiarity with monographic literature, software and correctly justified the solution of the problem (the number of points received 90-100).

Well evaluated studio, who firmly knows the program material, competent and essentially teaches it, does not suggest significant inaccuracies in answering the question, correctly applies theoretical provisions in solving practical questions and tasks: C (the number of points received 82-89), C (the number of points received 75-81).

The study, which knows only the main material, but has not learned its details satisfactorily, suggests inaccuracies in response, does not correctly formulate basic laws and rules, has complications in the implementation of practical tasks: D (the number of points received is 64-74), E (the number of points received is 60-63).

Unsatisfactory evaluate a student who does not know a significant part of the program material, makes significant mistakes, with complications performs practical tasks FX (the number of points received 35-59), unsatisfactory with the mandatory re-study of discipline F (the number of points received 0-34).

DISTRIBUTION OF POINTS RECEIVED BY STUDENTS

Table 1: Table 1 Use the < Points allocation to assess a student's current performance

Independent work	Individual task	Exam	Amount
T1 -T2			
20	30	50	100

Table 2. Individual task

Explanatory notes	Ilustrativeparticle	Zahistroboti	Amount
15	-	15	30

RECOMMENDED LITERATURE

Main literature:

1. Advanced Power Generation Systems - 1st Edition [Electronic resource]. URL: https://www.elsevier.com/books/advanced-power-generation-systems/dincer/978-0-12-383860-5 (accessed: 27.08.2021).

2.Electrochemical Energy Conversion and Storage Systems for Future Susta [Electronic resource]. URL: https://www.routledge.com/Electrochemical-Energy-Conversion-and-Storage-Systems-for-Future-Sustainability/Samantara-Ratha/p/book/9781771888851?utm_source=cjaffiliates&utm_medium=affiliates&cjevent=3fee33a2072511ec801f7db80a180514 (accessed: 27.08.2021).

3.Energy Storage for Power System Planning and Operation | Wiley [Electronic resource] // Wiley.com. URL: https://www.wiley.com/en-al/Energy+Storage+for+Power+System+Planning+and+Operation-p-9781119189084 (accessed: 27.08.2021).

4.Fundamentals of Thermal and Nuclear Power Generation - 1st Edition [Electronic resource]. URL: https://www.elsevier.com/books/fundamentals-of-thermal-and-nuclear-power-generation/koizumi/978-0-12-820733-8 (accessed: 27.08.2021).

5.Handbook of Energy Storage - Demand, Technologies, Integration | Michael Sterner | Springer [Electronic resource]. URL: https://www.springer.com/gp/book/9783662555033 (accessed: 27.08.2021).

6.Mechanical Energy Storage for Renewable and Sustainable Energy Resources | SpringerLink [Electronic resource]. URL: https://link.springer.com/book/10.1007/978-3-030-33788-9 (accessed: 27.08.2021).

7.Mechanical Energy Storage Technologies - 1st Edition [Electronic resource]. URL: https://www.elsevier.com/books/mechanical-energy-storage-technologies/arabkoohsar/978-0-12-820023-0 (accessed: 27.08.2021).

8.Novel Electrochemical Energy Storage Devices: Materials, Architectures, and Future Trends | Wiley [Electronic resource] // Wiley.com. URL: https://www.wiley.com/en-ae/Novel+Electrochemical+Energy+Storage+Devices%3A+Materials%2C+Architectures%2C+and+Future+Trends-p-9783527821068 (accessed: 27.08.2021).

9.Sallam A.A., Malik O.P. Power Grids with Renewable Energy: Storage, integration and digitalization. IET Digital Library, 2020.

10.Renewable energy conversion systems - 1st Edition [Electronic resource]. URL: https://www.elsevier.com/books/renewable-energy-conversion-systems/kamran/978-0-12-823538-6 (accessed: 27.08.2021).

11.Renewable-Energy-Driven Future - 1st Edition [Electronic resource]. URL: https://www.elsevier.com/books/renewable-energy-driven-future/ren/978-0-12-820539-6 (accessed: 27.08.2021).

12.Smart Energy Grid Engineering - 1st Edition [Electronic resource]. URL: https://www.elsevier.com/books/smart-energy-grid-engineering/gabbar/978-0-12-805343-0 (accessed: 27.08.2021).

13.Thermal, Mechanical, and Hybrid Chemical Energy Storage Systems - 1st Edition

[Electronic resource]. URL: https://www.elsevier.com/books/thermal-mechanical-and-hybrid-chemical-energy-storage-systems/brun/978-0-12-819892-6 (accessed: 27.08.2021).

Additional literature:

1. Fedorchuk S.O. et al. Modeling of distributed energy systems based on renewable energy sources // Energy management: state and prospects of development - PEMS'17. 2017.
2. Ivakhnov A.V., Lazurenko O.P., Fedorchuk S.O. Modeling of the system of accumulation of electricity as highly maneuvering power with the use of energy system in different units // Modelling of energy storage systems as highly maneuvering power using it in various nodes of power grid. Private Entrepreneur Panov A.M., 2018. № 195.
3. Ivakhnov A.V., Lazurenko A.P. Increase of reserves of balancing capacities of the energy system through the use of electric batteries. National technical university "Harkowski polythechnic instite", 2017. Vol. Part 2.
4. Lazurenko A.P., Krugol N.M., Ivakhnov A.V. Increasing the reserves of balancing capacities of the energy system of Ukraine through the use of electric batteries. National Technical University "Kharkiv Polytechnic Institute," 2017.
5. Ivakhnov A.V., Fedorchuk S.O., Lazurenko O.P. Systems of energy storage, analysis of capabilities and their combination for use in the power system // Power storage systems, opportunities analysis and their combinations for use in the power system. National Technical University "Kharkiv Polytechnic Institute", 2018. № №10(1286).
6. Fedorchuk S. et al. Optimization of Storage Systems According to the Criterion of Minimizing the Cost of Electricity for Balancing Renewable Energy Sources // 2020 IEEE KhPI Week on Advanced Technology (KhPIWeek). 2020. P. 519–525.

INFORMATION RESOURCES ON THE INTERNET

1. http://scilab.org
2. http://mathworks.com