MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

National Technical University
"Kharkiv Polytechnic Institute"

INTRODUCTION TO SPECIALTY. INTRODUCTORY PRACTICE

Typical program, methodical instructions and control tasks
for foreign students of specialty
141 – "Electric power engineering, electrical engineering and electromechanics"
educational and professional program "Electromechanics"

Approved
editorial and publishing
by the board of NTU "KhPI",
protocol No. 1 dated 16.02.2023

Kharkiv
NTU "KhPI"
2023

Introduction to Specialty. Introductory Practice: Typical program, methodical instructions and control tasks for foreign students of specialty 141 – "Electric power engineering, electrical engineering and electromechanics" educational and professional program "Electromechanics" / Compiler O. Yurieva. – Kharkiv : NTU "KhPI", 2023. – 12 p.

Compiler: O. Yuryeva

Reviewer: V. Shevchenko

Electrical Machines Department

INTRODUCTION

The educational and professional program "Electromechanics" is an integral part of the specialty "Electric power engineering, electrical engineering and electromechanics". Specialists in electromechanics solve technical problems in the research, development, production, operation, testing and maintenance of various electromechanical devices, which include electric machines and transformers. The educational and professional program "Electromechanics" studies electrical machines and transformers, which are used in all areas of human life.

The discipline "Introduction to Specialty" helps first-year students familiarize themselves with the field of activity of their future specialty. The discipline "Introduction to Specialty" for electrical machines studies the basic laws of electrical engineering, the letter designations of quantities, the main phenomena of the electromagnetic field, and introduces the variety of electric machines and transformers that ensure the operation of modern mechanisms. The curriculum of the discipline envisages familiarizing students with the structure of the university and its divisions, the history of the development of the university and the Electrical Machines Department, and the rules for using the library. The main task and goal of the discipline is the study of the history of knowledge and development of electricity, the basic laws of electric and magnetic phenomena, the history of the development of electric machines and transformers,

This methodical edition contains the program of the course "Introduction to Specialty", control questions for the sections of the course, methodological instructions for performing control tasks, as well as a list of sources of information necessary for studying the discipline.

1. GENERAL RECOMMENDATIONS FOR STUDYING THE DISCIPLINE

The study of the educational discipline "Introduction to the specialty. Introductory Practice" is based on the knowledge obtained of full secondary education, namely, in the mathematics, physics, and chemistry.

As a result of studying the discipline, the student should be able to formulate and explain the basic concepts, physical foundations and laws of electromagnetism, define electric, magnetic and energy quantities, know their measurement units and the relationship between them. The student must know the methods of obtaining, transmitting and using electrical energy in industry and in everyday life. Also, the student should know how the design of electrical machines and transformers developed from the simplest to modern ones. As a result of studying the discipline, the student should have an idea about the principle of operation of electrical machines and transformers, know the design features and differences in the principle of operation of the main types of electrical machines and transformers, must be able to determine the type of electrical machines and transformers for use in power plants and industrial enterprises.

The study of the discipline "Introduction to Specialty" by correspondence students takes place during independent work. The student must draw up a synopsis based on the studied material and answer questions for self-testing. After studying the discipline relevant sections, it is recommended to perform control tasks.

2. STRUCTURE OF THE DISCIPLINE

According to the bachelor's training plan, the discipline "Introduction to Specialty. Introductory Practice" is studied in the first year in the first semester. The curriculum provides 3.0 ECTS credits, which is 90 hours in total. For full-time (part-time) students, the discipline includes 16 (2) hours of lectures and 32 (4) hours of practical classes, 42 hours of independent work to complete the control task and prepare for the exam.

The discipline includes content modules: methodological foundations of study at the University; basic concepts and laws of electrical engineering; general information about electrical machines and transformers; structure and principle of operation of modern electric machines and transformers.

3. TYPICAL PROGRAM AND CONTROL QUESTIONS

Part 1. Methodological foundations of study at the University

Topic 1. Higher professional education in Ukraine and abroad

History, current state and prospects for the development of higher professional

education. Prospects for the development of modern science and technology. NTU "KhPI": history of establishment, structure, subdivisions. Characteristics of specialties and specializations of the Electrical Machines Department.

Topic 2. Organization of the educational process at NTU "KhPI"

Normative basis of the educational process of NTU "KhPI". Levels, degrees, standards and qualifications of higher education. Curriculum, educational program. Scientific mobility of students, internships and studies abroad. Opportunities provided to students thanks to the cooperation of NTU "KhPI" with other institutions (seminars, trainings, programs, etc.). The procedure for expulsion, interruption of studies, renewal and transfer of students of higher education.

Topic 3. Information and library resources of NTU "KhPI"

Scientific and technical library of NTU "KhPI" in the educational process: structure, service system and rules. The reference and search apparatus of the library. Algorithm for searching documents in alphabetical and systematic catalogs. Electronic resources of the library: full-text resources of electronic catalogs; repository History of NTU "KhPI" on the pages of the library website. Governing documents in librarianship. Information resources in the industry. Problem-oriented databases. Open access resources. The concept of sources to be referenced. Scientometric databases. Citation index. Copyrights for objects of the library fund and open access sources. Plagiarism. Official websites of NTU "KhPI" as sources of information: Website of the educational and scientific institute of energy, electronics and electromechanics and the department of electric machines.

Topic 4. Control activities. Organization and reporting at NTU "KhPI"

The procedure for conducting exams and assessments. Debt liquidation procedure. Regulations on the principles of forming a final grade on a 100-point scale for academic disciplines. Provisions on criteria and knowledge and skills assessment system.

Topic 5. Methodological recommendations for the work of students during their studies

Methodology of the student's work in classes: keeping a synopsis of lectures; execution of laboratory work reports; study of scientific literature, etc. Methods and forms of independent work. Completion of diploma, course and research work (project). Methods of writing theses, scientific articles. Preparation for speaking at conferences and other scientific and communicative events.

Topic 6. Social and legal protection of the student

Procedure for providing medical services. Student benefits, student camp, student palace, sports palace. Opportunities of students of NTU "KhPI" to realize their own educational, social, and research needs. Bodies of student self-government. Trade union organization of students and the career center.

Topic 7. Professional development of a student of higher education. The

evolution of character-level and content of engineering activity

Types of professions. Types of engineering activity. Professional suitability, professional orientation and professional selection. Stages of professional growth. The place and evolution of engineering activity in the technosphere. Modern requirements for a young specialist presented by the labor market.

Topic 8. Basic questions from the specialty

Theoretical foundations, basic terms and definitions from the specialty. Prospective directions of scientific research in the specialty. Implementation of new technologies aimed at reducing material costs, savings, and improving competitiveness. Ways to increase environmental safety of production and improve working conditions.

Control questions of part 1 content

1. What is the organizational structure of NTU "KhPI"?
2. According to which educational program does the NTU KhPI Electrical Machines Department of teach students?
3. According to what levels, degrees and qualifications of higher education are carried out-studying at NTU "KhPI"?
4. What are the rules for using library resources?
5. What are the rules for making a request during a search in the scientific database technical library of NTU "KhPI"?
6. List the results of the search for book publications in the specialty "Electrical Machines" in the scientific and technical library of NTU "KhPI".
7. Give examples of scientometric databases with the address of an Internet page.
8. Provide the address of the link to the methodical support that is located on the website of Electrical Machines Department "NTU KhPI".
9. What are the principles of forming a final grade on a 100-point scale in NTU "KhPI"?
10. Name the types of engineering activity.

Part 2. Basic concepts and laws of electrical engineering

Topic 1. Electrostatics

Electric field. Electrification of bodies. Electric charge. Two types of electric charges. Interaction of charged bodies. Coulomb's law. Electric field strength. Graphic representation of an electric field. Electrical conductivity of materials: conductors, semiconductors and dielectrics. Current in metals. Electrical capacity. Flat capacitor. Series and parallel connection of ideal capacitive elements.

Topic 2. Electric circuit

Electric circuit. Electric current. Amperage. Electric voltage. Electromotive

force (EMF). Electric resistance. Dependence of conductor resistance on its length, cross-sectional area and material. Specific resistance of the conductor. Dependence of conductor resistance on temperature. Ohm's law for a homogeneous section of an electric circuit. Ohm's law for a closed electric circuit. Series and parallel connection of ideal resistive elements. Calculations of simple electric circuits. Kirchhoff's first law. Kirchhoff's second law. Energy and power of electric current. The thermal action of the current. Joule-Lenz law. Direct and alternating currents. Sinusoidal current.

Topic 3. Magnetism

Magnetic field. Permanent magnets. Interaction of magnets. Magnetic induction. Magnetic flux. Graphic representation of the magnetic field. The magnetic field of a current-carrying conductor. Magnetic field of a coil with a current. Drill rule. The force of a magnetic field on a current-carrying conductor. Ampere's law. Left hand rule. Electromagnetic field. Electromagnetic induction. Right hand rule. The phenomenon of self-induction. EMF of self-induction. Inductance.

Topic 4. Energy conversion

Conversion of electrical energy to mechanical energy. Transformation of mechanical energy into electrical energy.

Control questions of part 2 content

1. Formulate Coulomb's law.
2. Graphically show the electric field of a separated charge, two one-positive and two opposite charges.
3. Describe the electrical conductivity of conductors, semiconductors, dielectrics.
4. Define electric capacity. Why is the electric capacity equal of a flat capacitor?
5. What is the equivalent capacity of an electric circuit section with series and parallel connected ideal capacitive elements?
6. What is the dependence of the resistance of the conductor on its length, cross-sectional area, material and temperature?
7. Formulate Ohm's law for a uniform section of an electric circuit.
8. Formulate Ohm's law for a closed electric circuit.
9. Why is the equivalent resistance of the section of the electric circuit equal to series and parallel connected ideal resistive elements?
10. Formulate Kirchhoff's first and second laws.
11. How the energy and power of an electric current is determined?
12. Formulate the Joule-Lenz law.
13. Describe direct and alternating current.
14. Define magnetic induction and magnetic flux.
15. Describe the force effect of a magnetic field on a current-carrying

conductor.

16. Describe the magnetic effect of current. Provide the drill rule (rule right hand).

17. Graphically depict the magnetic field of two parallel conductors with current of different and the same direction.

18. Describe the electromagnetic field and its components – electric field and magnetic field.

19. Formulate the law of electromagnetic induction in Faraday's formulation.

20. Formulate Ampere's law.

21. Formulate the rules of right and left hand.

22. Explain the phenomenon of self-induction. Define inductance.

23. Explain the principles of converting mechanical energy into electrical energy.

24. Explain the principles of converting electrical energy into mechanical energy.

Part 3. General information about electrical machines and transformers

Topic 1. The history of the development of direct current electric machines Experiments by H. Oersted and A. Ampere. Scheme of Faraday's installation. Faraday's disc. A dynamo machine is a prototype of electromechanical energy converters. Pixii's DC generator (Pixii Machine). Jacoby's motor. Jacoby's generator. Gram's generator with a ring armature. Development of a drum anchor.

Topic 2. The history of the development of AC electrical machines

Discovery of the rotating magnetic field phenomenon by H. Ferraris and N. Tesla. Wilde's single-phase generator. Yablochkov's electrical machines designs. The invention of three-phase asynchronous motors by M. Dolivo-Dobrovolsky.

Topic 3. The history of the development of transformers

Rumkorf's induction coil as a prototype of a transformer. Transformers by M. Faraday and J. Henry. Transformers with closed cores by Hopkinson brothers. Transformer by P. Yablochkov. Three-phase transformer by M. Dolivo-Dobrovolsky. Transformers with a toroidal core. Transformers with a W-shaped core. Transformers for parallel operation by O. T. Blathy, M. Deri, K. Zipernovsky.

Topic 4. General information about electric machines

The simplest scheme of an electromechanical converter. The reversibility principle of electrical machines. Operation of the electromechanical converter in the electric generator mode. The moments balance equation of the electrical generator. The voltages balance equation of the DC electrical generator. Losses of the electric generator. Useful power and efficiency of the electric generator. Operation of the electromechanical converter in the electric motor mode. Moments balance equation of the electrical motor. The voltage balance equation of the DC electrical motor. Losses

of the electrical motor. Useful power and efficiency of the electrical motor. Classification of electrical machines by type of current, principle actions, type of excitement.

Control questions of part 3 content

1. Draw a diagram and describe the operation of the Faraday's installation.
2. Draw a diagram and describe the operation of a unipolar machine (Faraday's disk).
3. Draw a diagram and describe the operation of a dynamo machine.
4. Draw a diagram and describe the operation of the Pixii Machine.
5. Draw a diagram and describe the operation of the Jacoby's motor.
6. Draw a diagram and describe the operation of the Gram's generator.
7. Draw a diagram and describe the operation of transformers by M. Faraday and J. Henry.
8. Draw a diagram and describe the operation of transformers with closed core by the Hopkinson brothers.
9. Describe the essence of the discovery of the phenomenon of a rotating magnetic field by G. Ferraris and N. Tesla.
10. Draw a diagram and describe the operation of a Wilde's generator.
11. Describe the essence of the invention of three-phase asynchronous motors by M. Dolivo-Dobrovolsky.
12. Describe the essence of using transformers for parallel work by O. T. Blathy, M. Deri, K. Zipernovsky.
13. Describe the essence of the principle of reversibility of electrical machines.
14. Draw a diagram and describe the operation of an electromechanical converter in electrical generator mode.
15. Write and explain the moments balance equation of an electrical generator Torah.
16. Write and explain the voltage balance equation of the DC electrical generator.
17. What are the losses in an electrical generator?
18. Explain the concepts of useful power and coefficient of useful action of electrical generator.
19. Draw a diagram and describe the operation of an electromechanical converter in electrical motor mode.
20. Write and explain the moments balance equation of the electric motor.
21. Write and explain the voltage balance equation of the DC electrical motor.
22. What are the losses in an electrical motor?
23. Explain the concepts of useful power and coefficient of useful action of

electrical motor.

24. Provide the electrical machines classification by type of current, principle actions, type of excitation.

Part 4. Structure and principle of operation of electrical machines and transformers

Topic 1. Transformers

Structure of the transformer. The principle of transformer operation.

Topic 2. Asynchronous machines

Structure of an asynchronous machine. The principle of operation of an asynchronous motor. The principle of operation of an asynchronous generator.

Topic 3. Synchronous machines

Structure of a synchronous machine. The principle of operation of a synchronous motor. The principle of operation of a synchronous generator.

Topic 4. DC machines

Structure of a DC machine. The principle of operation of a DC motor. The principle of operation of a DC generator.

Control questions of part 3 content

1. Describe the transformer construction and explain its operation principle.
2. Describe the asynchronous machine construction.
3. Explain the asynchronous motor principle of operation.
4. Explain the asynchronous generator principle of operation.
5. Describe the salient pole synchronous machine construction.
6. Describe the non-salient pole synchronous machine construction.
7. Explain the synchronous motor principle of operation.
8. Explain the synchronous generator principle of operation.
9. Describe the DC machine construction.
10. Explain the DC motor principle of operation.
11. Explain the DC generator principle of operation.
12. Explain the DC machine collector purpose.

4. METHODOLOGICAL INSTRUCTIONS FOR CONTROL TASK IMPLEMENTATION

The control task covers all parts of the discipline and consists of six control questions to which written answers must be provided. The task consists of control questions that correspond to the variants of the control task indicated in the table 1. The number of the option is issued to the student individually at the guidance classes during the session. The control task is graded after an interview with the teacher.

During the control task preparation, it is recommended to use sources of information [1, 2, 3, 6, 7] or others found independently, which must be cited at the control work end.

Answers to control questions should reflect the essence of the question, if necessary, contain explanatory drawings. Derivation of formulas should be consistent. All physical quantities must have letter designations indicating the units of measurement. Letter designations of quantities and their measurement units must comply with current standards [4]. The control task must be completed manually or by machine in accordance with the requirements of the standards [5].

Table 1 – Distribution of questions by options

Number option	Control questions numbers to part content				Number option	Control questions numbers to part content			
	1	2	3	4		1	2	3	4
1	1	7, 18	3, 9	2	7	7	5, 14	11, 23	7
2	2	12, 24	12, 22	1	8	8	8, 16	5, 15	8
3	3	1, 22	2, 24	3	9	9	9, 21	7, 17	9
4	4	3, 13	6, 13	4	10	10	2, 23	8, 19	10
5	5	11, 17	1, 18	5	11	11	4, 20	4, 16	11
6	6	10, 15	14, 21	6	12	12	6, 19	10, 20	12

LIST OF REFERENCES AND INFORMATION RESOURCES ON THE INTERNET

1. Tong D. Lectures on Electromagnetism. Access mode: https://www.damtp.cam.ac.uk/user/tong/em/electro.pdf.
2. Electrical Live. https://electricallive.com.
3. Britannica. https://www.britannica.com/science/electromagnetism.
4. Electronics-tutorials. https://www.electronics-tutorials.ws.
5. STZVO-KhPI-3.01-2018. Text documents in the field of educational process. General requirements for implementation
6. The official website of NTU "KhPI". http://www.kpi.kharkov.ua.
7. The official website of the Electrical Machines Department of NTU "KhPI". http://www.kpi.kharkiv.edu/kem.

Навчальне видання

ВСТУП ДО СПЕЦІАЛЬНОСТІ. ОЗНАЙОМЧА ПРАКТИКА

Типова програма, методичні вказівки та контрольні завдання
для іноземних студентів
спеціальності 141 «Електроенергетика, електротехніка та електромеханіка»
освітньо-професійної програми «Електромеханіка»

Укладач: ЮР'ЄВА Олена Юріївна

Відповідальний за випуск Мілих В. І.
Роботу до друку рекомендував Любарський Б. Г.
В авторській редакції

План 2023 р. п. 36

Підписано до друку . Формат 60x84 1/16. Папір офсетний.
Друк – ризографія. Гарнітура Times New Roman. Ум. друк. арк. 0,5.
Обл.-вид. арк. 0,38. Наклад – 50 прим. Зам. № . Ціна договірна.

Видавничий центр НТУ «ХПІ»
Свідоцтво про державну реєстрацію ДК № 5478 від 21.08.2017 р.
61002, Харків, вул. Кирпичова, 2

Друкарня НТУ "ХПІ", 61002, Харків, вул. Кирпичова, 2