NJSC SHAKARIM UNIVERSITY OF SEMEY

EDUCATIONAL PROGRAM

7M05 - Natural Sciences, Mathematics and Statistics
(Code and classification of the field of education)

7M053 - Physical and chemical sciences
(Code and classification of the direction of training)

0530
(Code in the International Standard Classification of Education)

M090 - Physics
(Code and classification of the educational program group)

7M05302 - Technical physics
(Code and name of the educational program)

Master
(Level of preparation)

Semey

Educational program

7M05 - Natural Sciences, Mathematics and Statistics
(Code and classification of the field of education)

7M053 - Physical and chemical sciences
(Code and classification of the direction of training)

0530
(Code in the International Standard Classification of Education)

M090 - Physics
(Code and classification of the educational program group)

7M05302 - Technical physics
(Code and name of the educational program)

Master
(Level of preparation)

Semey 2023

PREFACE

Developed

The educational program 7M05302 - Technical physics in the direction of preparation 7M053 - Physical and chemical sciences on the basis of the State Compulsory Standards of Higher and Postgraduate Education approved by the Order of the Ministry of Science and Higher Education of the Republic of Kazakhstan dated July 20, 2022 No 2 (as amended by the order) was developed by the Academic Committee dated 20.02.2023 No 66).

Members of the Academic Committee	Full name	Academic degree, academic title, position	Signature
Head of the Academic Committee	Nurymkhan Gulnur	Dean of the engineering-technological faculty, PhD	
Educational program manager	Yermolenko Mikhail	Senior Lecturer of the Department of Technical Physics and Thermal Power Engineering, candidate of technical sciences	
Member of the AC	Stepanova Olga	Head of the Department of Technical Physics and Thermal Power Engineering, candidate of technical sciences	
Member of the AC	Kassymov Askar	PhD, acting ass. professor of the department of Technical Physics and Thermal Power Engineering	
Member of the AC	Vityuk Vladimir	Deputy Director General for Science (National Nuclear Center of the Republic of Kazakhstan)	
Member of the AC	Mukhamedov Nurzhan	Head of the Department for Development and Testing of Reactor Devices of the Branch of the IAE RSE NNC RK	
Member of the AC	Zhasulan Ainur	Master s student group MTPh-101	
Member of the AC	Yediluly Alikhan	Master s student group MTPh-201	

Reviewing

Full name of the reviewer	Position, place of work	Signature
Chektybayev Baurzhan	Head of the Thermonuclear Research Department of the IAE branch of the RSE NNC RK	

Reviewed

at the meeting of the Quality Assurance Commission of the Faculty of Engineering and Technology
Recommended for approval by the Academic Council of the University
Protocol № 4.6 "10" April 2023
Chairman of the Commission on Quality Assurance Abdilova G.

Approved at the meeting of the Academic Council of the University Protocol No. 8 "25" April 2023.

Approved

at the meeting of the Academic Council of the University
Protocol № 1 "01" of September 2023
Chairman of the Academic Council of the University Orynbekov D.R.

Content

1.Introduction

1.1.General data

Training under the educational program 7M05302- Technical Physics is carried out at the Shakarim University of the city of Semey at the Department of Technical Physics and Heat Power Engineering of the Faculty of Engineering. When implementing the educational program, the peculiarities of training masters, characteristic of the Shakarim University of Semey and the region, were taken into account - these are educational trajectories of training "Nuclear Reactors and Power Plants", "Technology and Physics of Low Temperatures" and "Medical Physics". The uniqueness of this educational program lies in the fact that the training of specialists in this field is carried out in close cooperation with the National Nuclear Center of the Republic of Kazakhstan and the Center for Nuclear Medicine and Oncology of the city of Semey. These areas of specialization on the territory of the Republic of Kazakhstan are carried out only at the Shakarim University of the city of Semey. The assessment of the quality of training of future specialists in the framework of the defense of dissertations is carried out at the field meetings of the certification commission on the basis of the branch of the department in the NNC RK (Kurchatov) and the Center for Nuclear Medicine and Oncology in the city of Semey.

1.2.Completion criteria

The main criterion for the completion of the educational process for the preparation of masters of the scientific and pedagogical direction is the development of at least 88 credits of theoretical training, including 6 credits of pedagogical practice, 13 credits of research practice, as well as at least 24 credits of research work of a master`s student, including internships and the completion of a master`s thesis, at least 8 credits of the final attestations . A total of 120 credits.

1.3.Typical study duration: 2 years.

2.PASSPORT OF THE EDUCATIONAL PROGRAM

2.1.EP purpose	Preparation of competitive specialists with deep fundamental knowledge in the field of technical physics, able to work in modern conditions, rapidly changing technologies and a rapidly increasing amount of information.
2.2.Map of the training profile within the educational program	
Code and classification of the field of education	7M05 - Natural Sciences, Mathematics and Statistics
Code and classification of the direction of training	7M053 - Physical and chemical sciences
Code in the International Standard Classification of Education	0530
Code and classification of the educational program group	M090 - Physics
Code and name of the educational program	7M05302 - Technical physics
2.3.Qualification characteristics of the graduate	
Degree awarded / qualification	Master of Natural Sciences
Name of the profession / list of positions of a specialist	Design engineer, physics engineer, junior researcher, senior laboratory assistant, college teacher, university.
OQF qualification level (industry qualification framework)	7
Area of professional activity	Industry, energy industry, education, science, medicine.
Object of professional activity	Enterprises and firms of energy and technological profiles. Research institutions. Higher and secondary specialized educational institutions. Radiation Diagnostics and Therapy Centers.
Types of professional activity	Experimental and research. Organizational and managerial. Educational (teaching).
Graduate Model	Apply fundamental scientific, pedagogical, managerial, communicative knowledge and skills in professional activities. To form the strategy and structure of the organization of scientifc research and physico- mathematical modeling of nuclear facilities. To form the strategy and structure of the organization of scientifc research and computer-aided design in low-potential energy. To form the strategy and structure of the organization of scientifc research in the feld of measurement of ionizing radiation and mathematical methods of analysis for biomedical research. To develop measures for safe operation and research on modern NPPs, engineering networks and equipment. To operate the fundamental concepts of modern physics in the feld of nanotechnology, non- Newtonian fuids and energy production. To operate with the fundamental concepts of modern physics in the feld of visualization methods and nuclear-physical methods of diagnosis and therapy.

	To operate information in the feld of modern nuclear power plants, thermonuclear energy in matters of their safe operation and research activities. To operate information in the feld of modern low-temperature systems and research activities. To operate information in the feld of modern ionizing medical systems and research activities.

3.Modules and content of the educational program

Sociolinguistic and scientific-pedagogical activity

Apply fundamental scientific, pedagogical, managerial, communicative knowledge and skills in professional activities.

Foreign language (professional)

Discipline cycle	Basic disciplines
Discipline component	University component
SubjectID	26196 (3010725)
Course	1
Term	1
Credits count	3
Practical and seminar classes	30hours
Independent work of a student under the guidance of a teacher	20hours
Independent work of the student	40hours
Total	90hours
Knowledge control form	Examination

Short description of discipline

Mastery of general cultural, professional and special competencies for the implementation of professional activities, involving teaching free reading of original literature of the relevant branch of knowledge in a foreign language; development of oral communication skills in monological and dialogical form in the specialty; development of written scientific communication skills on topics related to the scientific work of a graduate student, as well as familiarization with the forms and types of international cooperation in the scientific field.

Purpose of studying of the discipline

The purpose of studying the discipline "Foreign language (professional)" in the master`s degree program is the systematic deepening of communicative competence within the framework of international standards of foreign language education on the basis of further development of skills and abilities of active language proficiency in the professional activity of the future master.

Learning Outcomes

ON1 Apply fundamental scientific, pedagogical, managerial, communicative knowledge and skills in professional activities.

Prerequisites

Bachelor

Postrequisites

Final examination

History and philosophy of science

Discipline cycle	Basic disciplines
Discipline component	University component
SubjectID	28322 (3010724)
Course	1
Term	1
Credits count	5
Lections	15hours
Practical and seminar classes	30hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline

The discipline is aimed at studying the culture of scientific thinking, forms analytical capabilities and research skills, provides theoretical and practical knowledge necessary for a future scientist. Explores the historical evolution of the sciences and the philosophical perspectives they form. The origins of modern science, its social and institutional connections are described. General philosophical issues related to thought experiments, confirmation and refutation of theories, the origin and application of quantitative and high-quality research methods are considered.

Purpose of studying of the discipline

the formation of an interdisciplinary worldview among undergraduates, based on a deep understanding of the history and philosophy (theory) of scientific thinking, as part of a universal culture.

Learning Outcomes

ON1 Apply fundamental scientific, pedagogical, managerial, communicative knowledge and skills in professional activities.

Prerequisites

Bachelor

Postrequisites

Final examination

Tertiary education

Discipline cycle	Basic disciplines
Discipline component	University component

SubjectID	28323 (3010726)
Course	1
Term	1
Credits count	3
Lections	15hours
Practical and seminar classes	15hours
Independent work of a student under the guidance of a teacher	20hours
Independent work of the student	40hours
Total	90hours
Knowledge control form	Examination

Short description of discipline
The course is aimed at studying the main directions, principles and patterns of higher education. During the course of the course, the basic concepts of modern pedagogy, concepts and theories of teaching and upbringing, didactics of higher education will be considered. The master`s student will master the skills of designing the organization of the educational process, techniques of individual and group reflection, will be able to correctly formulate pedagogical goals, apply educational technologies in the educational process. in the process, to design work programs of disciplines.

Purpose of studying of the discipline
The purpose of mastering the discipline is to master the system of knowledge about higher education, its content, structure, principles of educational process management and mastering modern technologies in the field of management and organization of the educational process

Learning Outcomes
ON1 Apply fundamental scientific, pedagogical, managerial, communicative knowledge and skills in professional activities.

Prerequisites
Bachelor

Postrequisites
Pedagogical practice

Psychology of management

Discipline cycle	Basic disciplines
Discipline component	University component
SubjectID	28321 (3010723)
Course	1
Term	1
Credits count	3
Lections	15hours
Practical and seminar classes	15hours
Independent work of a student under the guidance of a teacher	20hours
Independent work of the student	40hours
Total	90hours
Knowledge control form	Examination

Short description of discipline
The content of the course is aimed at mastering the approaches and directions of management psychology, psychological laws of management, features of planning and solving management problems. Students will get acquainted with the psychological methods of resolving conflict situations, master the ways of motivating work, the methods of using effective management styles. Skills will be formed to analyze the psychological causes underlying the decline in the effectiveness of the management process.

Purpose of studying of the discipline
The purpose of the discipline "Psychology of Management" is the formation of scientifically based ideas about the system of mental phenomena, psychological variables of behavior and conscious human activity in modern conditions and allows undergraduates to form skills of applying the acquired psychological knowledge in educational activities

Learning Outcomes
ON1 Apply fundamental scientific, pedagogical, managerial, communicative knowledge and skills in professional activities.

Prerequisites
Bachelor

Postrequisites
Final examination

Pedagogical practice

Discipline cycle	Basic disciplines
Discipline component	University component
SubjectID	28378 (3010687)
Course	2
Term	1
Credits count	6
Pedagogical practics	180hours
Total	180hours

Knowledge control form	Total mark on practice

Short description of discipline
The pedagogical practice of the undergraduate is an important practical component of the second stage of higher education. This type of practice is aimed at mastering the basics of pedagogical skills, leading a group of students and developing educational and methodological material. The passage of pedagogical practice involves the formation of concepts about modern educational technologies, forms and methods of conducting classes, monitoring the assimilation of the studied material. Pedagogical practice contributes to the development of undergraduates` self-analysis skills based on the results of the work done.

Purpose of studying of the discipline
The purpose of teaching practice is to study the basics of educational and methodical work and the formation of practical skills and methods of teaching in higher education.

Learning Outcomes
ON1 Apply fundamental scientific, pedagogical, managerial, communicative knowledge and skills in professional activities.

Prerequisites
Tertiary education

Postrequisites
Final examination

Organization of scientific research in technical physics

To form the strategy and structure of the organization of scientific research and physico- mathematical modeling of nuclear facilities. To form the strategy and structure of the organization of scientific research and computer-aided design in low- potential energy.To form the strategy and structure of the organization of scientific research in the field of measurement of ionizing radiation and mathematical methods of analysis for biomedical research. To develop measures for safe operation and research on modern NPPs, engineering networks and equipment. To operate with the fundamental concepts of modern physics in the field of visualization methods and nuclear-physical methods of diagnosis and therapy. To operate information in the field of modern ionizing medical systems and research activities.

Scientific research methodology

Discipline cycle	Basic disciplines
Discipline component	Electives
SubjectID	28278 (3010689)
Course	1
Term	1
Credits count	5
Lections	15hours
Practical and seminar classes	30hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline
The course describes in detail the methodological support of research activities. The role of the functional structure of research activity is shown. Empirical and theoretical thinking in scientific cognition is analyzed. The confirmations and refutations of theoretical schemes are formulated and substantiated. The functional features of experimental modeling are generalized. An explanation of the growth of scientific knowledge is given. The importance of functional and procedural characteristics of hypotheses and their scientific novelty is shown.

Purpose of studying of the discipline
To form in students the principles and methods of organizing scientific research.

Learning Outcomes
ON2 To form the strategy and structure of the organization of scientific research and physico- mathematical modeling of nuclear facilities.
ON3 To form the strategy and structure of the organization of scientific research and computer-aided design in low-potential energy.

Prerequisites
Bachelor

Postrequisites
Final examination

Methods of measurement of ionizing radiation and the properties of nuclear materials

Discipline cycle	Basic disciplines
Discipline component	Electives
SubjectID	28343 (3010719)
Course	1
Term	1
Credits count	5
Lections	15hours
Practical and seminar classes	30hours
Independent work of a student under the guidance of a teacher	35hours

Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline
This course examines the categories of nuclear materials (NM) and the requirements for the accuracy and multiplicity of measurements. The balance of nuclear materials and the balance equation are considered. Accounting and confirming measurements of nuclear materials, non-destructive methods of nuclear materials analysis and calibration of the measuring system are given. Determination of the content of wells in samples by measuring their own gamma radiation and gamma spectrometric measurements is discussed. The fundamentals of the theory of radiation transfer and multiple scattering are given.

Purpose of studying of the discipline
Presentation of measurement methods of nuclear materials and ionizing radiation fields, acquiring skills in conducting these measurements and processing the results.

Learning Outcomes
ON4 To form the strategy and structure of the organization of scientific research in the field of measurement of ionizing radiation and mathematical methods of analysis for biomedical research.
ON10 To operate information in the field of modern ionizing medical systems and research activities.

Prerequisites
Bachelor

Postrequisites
Final examination

Methods of processing signals and images in medicine

Discipline cycle	Basic disciplines
Discipline component	Electives
SubjectID	28342 (3010721)
Course	1
Term	1
Credits count	5
Lections	15hours
Practical and seminar classes	15hours
Laboratory works	15hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline
This course is dedicated to digital images used in medicine. It examines image quality and basic image operations. The classification and distinctive feature of medical images is given. The analysis of medical images and verification of analysis algorithms is given. The features of visualization for diagnosis and therapy are considered. Mathematical modeling as a method of analyzing biological processes is given. The approximation of typical biological signals and the analysis of biological noises are considered.

Purpose of studying of the discipline
Formation of the theoretical concepts and practical skills of modulating biological objects and analysis' of biological signals and biological noise.

Learning Outcomes
ON4 To form the strategy and structure of the organization of scientific research in the field of measurement of ionizing radiation and mathematical methods of analysis for biomedical research.
ON7 To operate with the fundamental concepts of modern physics in the field of visualization methods and nuclear-physical methods of diagnosis and therapy.
ON10 To operate information in the field of modern ionizing medical systems and research activities.

Prerequisites
Bachelor

Postrequisites
Final examination

Organization and planning of scientific research

Discipline cycle	Basic disciplines
Discipline component	Electives
SubjectID	28339 (3010717)
Course	1
Term	1
Credits count	5
Lections	15hours
Practical and seminar classes	30hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours

Knowledge control form	Examination

Short description of discipline
The course is devoted to the organization and planning of scientific research. The methodological foundations of scientific knowledge and creativity are outlined. The choice of the direction of scientific research and the development of stages of research work are highlighted. The requirements for the search, accumulation and processing of scientific information are considered. The principles of theoretical and experimental research are described. Modeling in scientific and technical creativity has been analyzed. The methods of processing the results of experimental studies are generalized. The requirements for the design of the results of scientific work are formulated.

Purpose of studying of the discipline
Development of elements of research methodology for the development of creative thinking and rational organization of optimal mental activity.

Learning Outcomes
ON2 To form the strategy and structure of the organization of scientific research and physico- mathematical modeling of nuclear facilities.
ON3 To form the strategy and structure of the organization of scientific research and computer-aided design in low-potential energy.

Prerequisites
Bachelor

Postrequisites
Final examination

The basic principles of the design of instruments and equipment

Discipline cycle	Basic disciplines
Discipline component	Electives
SubjectID	28276 (3010688)
Course	1
Term	1
Credits count	5
Lections	15hours
Practical and seminar classes	30hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline
This course discusses the theoretical foundations of design and engineering with the development of technical specifications. The structure and design features of various devices, as well as the principles of the development of the terms of reference are given. Attention is paid to the formulation of goals and objectives. The design documentation and its classification are considered. The main groups of technical documentation and specifications are given. The design technology, operational properties and reliability of devices and equipment are considered.

Purpose of studying of the discipline
To form a competency-based approach in the field of designing instruments and equipment in the field of technical physics among students.

Learning Outcomes
ON3 To form the strategy and structure of the organization of scientific research and computer-aided design in low-potential energy.
ON5 To develop measures for safe operation and research on modern NPPs, engineering networks and equipment.
ON9 To operate information in the field of modern low-temperature systems and research activities.

Prerequisites
Bachelor

Postrequisites
Final examination

Basics of CAD low potential energy

Discipline cycle	Basic disciplines
Discipline component	Electives
SubjectID	28337 (3010691)
Course	1
Term	1
Credits count	5
Lections	15hours
Practical and seminar classes	30hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline
This course discusses the goals and objectives of mathematical modeling of low-potential energy facilities. Frequently used methods of

optimization of simulated objects, types of ideal models and the method of thermoeconomics are given. The main methods of modeling and dynamic optimization of refrigeration units and air conditioning systems are considered, taking into account seasonal changes in outdoor air temperature and the magnitude of loads. Attention is paid to computer-aided design systems.

Purpose of studying of the discipline

The purpose of this course is to develop the skill of research and design work in the field of refrigeration engineering with the formulation and conduct of simulation experiments with models of heat and mass transfer processes occurring in heat exchangers of a computer-based refrigeration plant.

Learning Outcomes

ON3 To form the strategy and structure of the organization of scientific research and computer-aided design in low-potential energy.
ON9 To operate information in the field of modern low-temperature systems and research activities.

Prerequisites

Bachelor

Postrequisites

Final examination

Theory and Techniques of a scientific experiment

Discipline cycle	Basic disciplines
Discipline component	Electives
SubjectID	28338 (3010692)
Course	1
Term	1
Credits count	5
Lections	15hours
Practical and seminar classes	15hours
Laboratory works	15hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline

The course discusses in detail the methods of experiment planning. The possibilities of using single-factor, fractional factor and full factor experiments and rotatable plans in research are being studied. Optimization problems in extreme experiments are shown. Special measurement questions, error theory, mathematical statistics, probability theory and measuring instruments are considered. Methods and means of thermal measurements, thermal analysis, methods of experimental study of heat and mass transfer processes are generalized.

Purpose of studying of the discipline

Building knowledge and skills in the field of modern methods and means of scientific and industrial experiments

Learning Outcomes

ON2 To form the strategy and structure of the organization of scientific research and physico- mathematical modeling of nuclear facilities.
ON3 To form the strategy and structure of the organization of scientific research and computer-aided design in low-potential energy.
ON4 To form the strategy and structure of the organization of scientific research in the field of measurement of ionizing radiation and mathematical methods of analysis for biomedical research.

Prerequisites

Bachelor

Postrequisites

Final examination

Theory and technique of heating experiment

Discipline cycle	Basic disciplines
Discipline component	Electives
SubjectID	28340 (3010693)
Course	1
Term	1
Credits count	5
Lections	15hours
Practical and seminar classes	15hours
Laboratory works	15hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline

The course examines the elements of the theory of experimental planning, regression and static analysis. An overview of technical measurements and devices is given. The methods of experimental study of thermophysical properties of substances and processes of heat and mass transfer, methods and means of control of technical materials and metals of thermal power thermal technology

installations are generalized. Methods of quality control of raw materials, fuels and products of heat-technological productions and metrological support of production and experimental research are presented.

Purpose of studying of the discipline

Mastering the basics of metrology and measurement technology, the formation of knowledge and skills in the field of modern methods and means of scientific and industrial experiments in the field of power and heat.

Learning Outcomes

ON2 To form the strategy and structure of the organization of scientific research and physico-mathematical modeling of nuclear facilities.
ON5 To develop measures for safe operation and research on modern NPPs, engineering networks and equipment.

Prerequisites

Bachelor

Postrequisites

Final examination

Physics and mathematics modeling of nuclear power plants

Discipline cycle	Basic disciplines
Discipline component	Electives
SubjectID	28279 (3010690)
Course	1
Term	1
Credits count	5
Lections	15hours
Practical and seminar classes	30hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline

This course examines the main areas of application of electronic computers in physical research. The features of the formulation of the computational experiment are considered in detail. Numerical integration of functions of one variable and multiple integrals are given. Finite-difference methods for solving differential equations, applied to nuclear reactors, are considered. A technique for modeling the motion of a particle in a force field is given. The characteristic of neutron-physical problems and an algorithm for modeling physical processes in nuclear reactors are given

Purpose of studying of the discipline

Preparation of undergraduates to solve engineering problems of analysis and calculation of nuclear power plants based on rigorous scientific methods.

Learning Outcomes

ON2 To form the strategy and structure of the organization of scientific research and physico-mathematical modeling of nuclear facilities.
ON5 To develop measures for safe operation and research on modern NPPs, engineering networks and equipment.
ON8 To operate information in the field of modern nuclear power plants, thermonuclear energy in matters of their safe operation and research activities.

Prerequisites

Bachelor

Postrequisites

Final examination

Fundamental concepts of modern physics

To form the strategy and structure of the organization of scientific research and physico-mathematical modeling of nuclear facilities. To operate the fundamental concepts of modern physics in the field of nanotechnology, non-Newtonian fluids and energy production. To operate with the fundamental concepts of modern physics in the field of visualization methods and nuclear-physical methods of diagnosis and therapy. To operate information in the field of modern ionizing medical systems and research activities.

Selected chapters of modern physics

Discipline cycle	Profiling discipline
Discipline component	University component
SubjectID	28364 (3010716)
Course	1
Term	2
Credits count	5
Lections	30hours
Practical and seminar classes	15hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours

Knowledge control form	Examination

Short description of discipline
This discipline is devoted to the discussion of non-trivial and interesting physical problems of modern physics. The classical mechanics of a material point and the principle of relativity in classical physics and relativistic physics are considered. The thermodynamics of ideal and thermodynamics of real gases, statistical methods used in physics are considered. Some macroscopic quantum effects and high-temperature superconductivity are discussed. The fundamentals of atomic physics, quantum mechanics and elements of mesoscopic physics are given.

Purpose of studying of the discipline
Formation of masters` ideas about modern physics as a whole, as a logically coherent system of knowledge about the laws of Nature for the creation of new technologies and the management of technical means.

Learning Outcomes
ON6 To operate the fundamental concepts of modern physics in the field of nanotechnology, non- Newtonian fluids and energy production.
ON8 To operate information in the field of modern nuclear power plants, thermonuclear energy in matters of their safe operation and research activities.

Prerequisites
Bachelor

Postrequisites
Final examination

Magnetic resonance methods

Discipline cycle	Profiling discipline
Discipline component	Electives
SubjectID	28363 (3010700)
Course	1
Term	2
Credits count	5
Lections	30hours
Practical and seminar classes	15hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline
This course examines the history of the creation of MRI and the principles of magnetic resonance. The types of magnetic resonances and their applications are given. The idea of spin-lattice and spin-spin relaxation is given. The concept of self-diffusion and the method of its measurement by gradient NMR are considered. The methods of obtaining an image in a magnetic resonance study are considered. A quantum mechanical description of the phenomenon of magnetic resonance and the nature of the anisotropy of the spectra is given.

Purpose of studying of the discipline
Formation by postgraduates of knowledge in the field of various methods of magnetic resonance and typical areas of their applying.

Learning Outcomes
ON6 To operate the fundamental concepts of modern physics in the field of nanotechnology, non- Newtonian fluids and energy production.
ON7 To operate with the fundamental concepts of modern physics in the field of visualization methods and nuclear-physical methods of diagnosis and therapy.

Prerequisites
Bachelor

Postrequisites
Final examination

Mechanics of continuous media

Discipline cycle	Profiling discipline
Discipline component	Electives
SubjectID	28358 (3010697)
Course	1
Term	2
Credits count	5
Lections	15hours
Practical and seminar classes	30hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline
In this discipline, mechanics with its basic laws and equations and kinematics with the necessary dynamic equations of motion of continuous media are considered. The equations of motion of an ideal fluid, plane-parallel and wave motion, and equations of two-

dimensional layered motion of an ideal fluid on a curved surface are considered. An idea of the motion of a viscous liquid is given. Equations and some problems of elasticity theory are given.

Purpose of studying of the discipline

To introduce undergraduates to the basic physical phenomena studied continuum mechanics, and to a certain extent, with elements of the mathematical apparatus used by it.

Learning Outcomes

ON6 To operate the fundamental concepts of modern physics in the field of nanotechnology, non- Newtonian fluids and energy production.
ON8 To operate information in the field of modern nuclear power plants, thermonuclear energy in matters of their safe operation and research activities.
ON9 To operate information in the field of modern low-temperature systems and research activities.

Prerequisites

Bachelor

Postrequisites

Final examination

The research work of a student, including an internship and the implementation of a master s thesis I

Discipline cycle	Profiling discipline
Discipline component	University component
SubjectID	28346 (3010710)
Course	1
Term	2
Credits count	11
The research work	330hours
Total	330hours
Knowledge control form	Total mark on practice

Short description of discipline

Research work develops the ability to independently carry out activities in the field of education and science related to solving complex professional tasks in innovative conditions, ensuring the development of professional research thinking of undergraduates, forming a clear understanding of their main professional tasks, ways to solve them, conducting bibliographic work with the involvement of modern information technologies.

Purpose of studying of the discipline

Preparation of a master`s student for independent research work aimed at writing and defending a master`s thesis.

Learning Outcomes

ON2 To form the strategy and structure of the organization of scientific research and physico- mathematical modeling of nuclear facilities.
ON3 To form the strategy and structure of the organization of scientific research and computer-aided design in low-potential energy.
ON4 To form the strategy and structure of the organization of scientific research in the field of measurement of ionizing radiation and mathematical methods of analysis for biomedical research.

Prerequisites

Bachelor Organization and planning of scientific research

Postrequisites

The research work of a student, including an internship and the implementation of a masters thesis II

Basic principles of modern physics (in English)

Discipline cycle	Profiling discipline
Discipline component	Electives
SubjectID	28360 (3010699)
Course	1
Term	2
Credits count	5
Lections	30hours
Practical and seminar classes	15hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline

This course examines the basic properties of space-time and their relationship to conservation laws. The principle of relativity and its consequences are given. The concept and definition of the phase space of states of a physical system are given. Reversible and irreversible dynamics are covered in detail. The concepts of chaos and structure are given. An evolutionary and structural description of the physical system is given. The role of symmetry principles is considered.

Purpose of studying of the discipline

The formation of students of modern physical thinking about the physical world.

Learning Outcomes

ON2 To form the strategy and structure of the organization of scientific research and physico- mathematical modeling of nuclear facilities.
ON6 To operate the fundamental concepts of modern physics in the field of nanotechnology, non- Newtonian fluids and energy production.

Prerequisites

Bachelor

Postrequisites

Final examination

Basics of cogeneration

Discipline cycle	Profiling discipline
Discipline component	Electives
SubjectID	28354 (3010694)
Course	1
Term	2
Credits count	5
Lections	15hours
Practical and seminar classes	30hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline

In this discipline, cogeneration plants and prospects for their use are considered. Power units based on gas piston engines (GPE), gas turbine, combined-cycle, solid fuel and biogas cogeneration plants are considered. The issues of cogeneration and small-scale energy at food industry and agriculture enterprises are considered. The idea of trigeneration and environmental problems in the production of thermal and electrical energy is given.

Purpose of studying of the discipline

Formation of knowledge of the basics of design, installation and operation of cogeneration plants.

Learning Outcomes

ON6 To operate the fundamental concepts of modern physics in the field of nanotechnology, non- Newtonian fluids and energy production.
ON8 To operate information in the field of modern nuclear power plants, thermonuclear energy in matters of their safe operation and research activities.
ON9 To operate information in the field of modern low-temperature systems and research activities.

Prerequisites

Bachelor

Postrequisites

Final examination

Basics of nanotechnology

Discipline cycle	Profiling discipline
Discipline component	Electives
SubjectID	28359 (3010698)
Course	1
Term	2
Credits count	5
Lections	30hours
Practical and seminar classes	15hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline

This course is devoted to the development trends of nanotechnology. Molecular beam epitaxy and chemical deposition from the gaseous phase are considered. Modern methods using scanning probes and scanning tunneling microscopy are given. Atomic force microscopy and atomic engineering are being studied. Probe methods for the formation of nanostructures and methods for the formation of nanoscale images are discussed. The features of self-regulating processes and the formation of nanostructured materials and coatings are analyzed in detail.

Purpose of studying of the discipline

Acquaintance with the basic physical phenomena studied by nanotechnologies and with the elements of the mathematical apparatus used by them.

Learning Outcomes

ON2 To form the strategy and structure of the organization of scientific research and physico- mathematical modeling of nuclear facilities.
ON6 To operate the fundamental concepts of modern physics in the field of nanotechnology, non- Newtonian fluids and energy production.

Prerequisites
Bachelor

Postrequisites
Final examination

Fundamentals of nuclear physics in the application to medicine

Discipline cycle	Profiling discipline
Discipline component	Electives
SubjectID	28367 (3010720)
Course	1
Term	2
Credits count	5
Lections	15hours
Practical and seminar classes	30hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline
This course is devoted to the use of nuclear physics in the diagnosis of human organs and the use of recording equipment. The history of the development of nuclear medicine, the properties of atomic nuclei and radioactive transformations of nuclei are considered. The concept of radioactivity, dosimetry is given. The use of radioactive radiation for diagnostics and radiation therapy is considered. The degree of exposure to ionizing radiation is given. Magnetic resonance imaging, computed tomography and the production of radiopharmaceuticals are being analyzed.

Purpose of studying of the discipline
Providing of necessarily stage of knowledge of the nuclear physics basis, which needs for use of the phenomenon of nuclear physics for science – technical diagnostic and therapeutic tasks in medicine and biology.

Learning Outcomes
ON6 To operate the fundamental concepts of modern physics in the field of nanotechnology, non- Newtonian fluids and energy production.
ON7 To operate with the fundamental concepts of modern physics in the field of visualization methods and nuclear-physical methods of diagnosis and therapy.

Prerequisites
Bachelor

Postrequisites
Final examination

Modern methods of energy conversion

Discipline cycle	Profiling discipline
Discipline component	Electives
SubjectID	28355 (3010695)
Course	1
Term	2
Credits count	5
Lections	15hours
Practical and seminar classes	30hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline
This discipline is devoted to the problem of obtaining and converting energy. Primary energy resources, mechanical, electrical, electromagnetic, chemical, nuclear energy, gravitational forces, power and flow energy are considered. An idea is given about the methods of heat energy transfer and the efficiency of a thermal piston engine. The complex use of thermal and electrical energy, problems of electromagnetic energy conversion, electrochemical energy storage and nuclear power plant are considered.

Purpose of studying of the discipline
Creation of knowledge bases of the problem of obtaining, transformation, transmission and energy storage.

Learning Outcomes
ON6 To operate the fundamental concepts of modern physics in the field of nanotechnology, non- Newtonian fluids and energy production.
ON8 To operate information in the field of modern nuclear power plants, thermonuclear energy in matters of their safe operation and research activities.

ON9 To operate information in the field of modern low-temperature systems and research activities.

Prerequisites

Bachelor

Postrequisites

Final examination

Physics of rheological fluids

Discipline cycle	Profiling discipline
Discipline component	Electives
SubjectID	28357 (3010696)
Course	1
Term	2
Credits count	5
Lections	15hours
Practical and seminar classes	30hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline

In this discipline, non- Newtonian fluids with rheological characteristics that are independent and time- dependent are considered. Viscoelastic fluids and the dependences between the pressure drop and the throughput under the laminar flow regime of the fluid in round pipes are considered. An idea of heat exchange in laminar and turbulent flow in a pipe is given. Pressing of molten polymers and mixing of non-Newtonian liquids are considered.

Purpose of studying of the discipline

The study of the theoretical foundations of non-Newtonian fluid dynamics and heat transfer fluids.

Learning Outcomes

ON6 To operate the fundamental concepts of modern physics in the field of nanotechnology, non- Newtonian fluids and energy production.
ON8 To operate information in the field of modern nuclear power plants, thermonuclear energy in matters of their safe operation and research activities.
ON9 To operate information in the field of modern low-temperature systems and research activities.

Prerequisites

Bachelor

Postrequisites

Final examination

Physical methods of visualization

Discipline cycle	Profiling discipline
Discipline component	Electives
SubjectID	28366 (3010718)
Course	1
Term	2
Credits count	5
Lections	15hours
Practical and seminar classes	30hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline

In this discipline, X-rays and image acquisition are considered. The principles of computer X-ray tomography and digital angiography are given. The features of the use of ultrasound for visualization and image acquisition using radioisotopes are given. MR and EPR tomography are considered. The issues of using infrared radiation to obtain images and visualization by the distribution of electrical impedance are highlighted. The analysis of various visualization methods is given.

Purpose of studying of the discipline

Study of the visualization principals, their processing and applying of medical presentation, therapy and studying

Learning Outcomes

ON8 To operate information in the field of modern nuclear power plants, thermonuclear energy in matters of their safe operation and research activities.
ON10 To operate information in the field of modern ionizing medical systems and research activities.

Prerequisites

Bachelor

Postrequisites

Final examination

Modern directions of technical physics

To form the strategy and structure of the organization of scientific research and physico- mathematical modeling of nuclear facilities. To form the strategy and structure of the organization of scientific research and computer-aided design in low- potential energy.To form the strategy and structure of the organization of scientific research in the field of measurement of ionizing radiation and mathematical methods of analysis for biomedical research. To develop measures for safe operation and research on modern NPPs, engineering networks and equipment. To operate with the fundamental concepts of modern physics in the field of visualization methods and nuclear-physical methods of diagnosis and therapy. To operate information in the field of modern ionizing medical systems and research activities.

Perspectives and heat physics problems of heat refrigerants technique

Discipline cycle	Profiling discipline
Discipline component	Electives
SubjectID	28381 (3010702)
Course	2
Term	1
Credits count	5
Lections	30hours
Practical and seminar classes	15hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline

This course presents the theoretical foundations of obtaining low and ultra-low temperatures. An analytical description of heat transfer processes is given. Approximate methods for solving the equations of thermal conductivity and diffusion for the conditions of heat treatment of products are considered. The basic concepts and methods of calculating the processes of cooling, freezing and defrosting of products are given. Freeze drying, cold storage and heat treatment of products are considered.

Purpose of studying of the discipline

The purpose of this course is to form a complex of knowledge in the field of low- temperature technology and high- temperature production

Learning Outcomes

ON3 To form the strategy and structure of the organization of scientific research and computer-aided design in low-potential energy.
ON9 To operate information in the field of modern low-temperature systems and research activities.

Prerequisites

Bachelor

Postrequisites

Final examination

Atomic power stations

Discipline cycle	Profiling discipline
Discipline component	Electives
SubjectID	28386 (3010706)
Course	2
Term	1
Credits count	5
Lections	15hours
Practical and seminar classes	30hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline

TThis course covers energy resources and the production of electrical energy. The criteria for the selection of steam parameters at nuclear power plants with regenerative heating of feed water and water coolant are disclosed. The description of the steam generator plant of a nuclear power plant with PWPR and a reactor plant with a water coolant is given. The issues of technical water supply and layout of NPP equipment are considered. Ventilation and decontamination installations and thermal schemes are considered. Nuclear power plant.

Purpose of studying of the discipline

The theoretical and practical skills related to the choice of parameters and the type of equipment in the design and operation of nuclear power plants and AST in the power in stationary, transient and accident conditions.

Learning Outcomes

ON5 To develop measures for safe operation and research on modern NPPs, engineering networks and equipment.
ON8 To operate information in the field of modern nuclear power plants, thermonuclear energy in matters of their safe operation and research activities.

Prerequisites

Bachelor

Postrequisites

Final examination

Safe operation of nuclear power plants

Discipline cycle	Profiling discipline
Discipline component	Electives
SubjectID	28380 (3010701)
Course	2
Term	1
Credits count	5
Lections	30hours
Practical and seminar classes	15hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline

In this discipline, the factors of potential safety of nuclear power plants (NPP) and possible ways of manifestation of hazards are considered. The types of accidents of nuclear power plants are given. The system of state and international requirements for the implementation of technical operation is considered. The requirements for the technical condition of the nuclear power plant and the requirements for safety management systems are given. The ways of improving the security management system are considered.

Purpose of studying of the discipline

Development of a set of interrelated issues of security at all stages of the operation of nuclear power plants.

Learning Outcomes

ON5 To develop measures for safe operation and research on modern NPPs, engineering networks and equipment.
ON8 To operate information in the field of modern nuclear power plants, thermonuclear energy in matters of their safe operation and research activities.

Prerequisites

Bachelor

Postrequisites

Final examination

Hydrogen energetics

Discipline cycle	Profiling discipline
Discipline component	Electives
SubjectID	28391 (3010713)
Course	2
Term	1
Credits count	5
Lections	15hours
Practical and seminar classes	30hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline

This course discusses the properties, methods of obtaining, storing and transporting hydrogen. The issues of atomic-hydrogen energy and controlled thermonuclear fusion are revealed. New directions in hydrogen production are described. The main research directions in the field of hydrogen energy and energy technologies are given. A comparative analysis of modern methods of hydrogen production is given and promising directions of hydrogen energy in the world are shown.

Purpose of studying of the discipline

Formation in students of the principles of obtaining and storing hydrogen in the field of hydrogen energy.

Learning Outcomes

ON5 To develop measures for safe operation and research on modern NPPs, engineering networks and equipment.
ON8 To operate information in the field of modern nuclear power plants, thermonuclear energy in matters of their safe operation and research activities.

Prerequisites

Bachelor

Postrequisites

Final examination

Cryogenic technique

Discipline cycle	Profiling discipline
Discipline component	Electives
SubjectID	28387 (3010707)

Course	2
Term	1
Credits count	5
Lections	15hours
Practical and seminar classes	30hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline
In this discipline, the scope of application, physical research and properties of cryoagents are considered. The ideal cycle and cascade liquefaction, cryogenic systems with the use of throttle effect and expansion in expanders are given. Refrigeration and liquefaction systems, features of the Kapitsa and Claude cycle are considered. The process of hydrogen and helium liquefaction and air separation is considered. Microcryogenic systems and medical cryoapparation are presented.

Purpose of studying of the discipline
The study of the issues and the cooling medium to below 120 K and the study of the processes and phenomena occurring in machines and devices cryogenic technology

Learning Outcomes
ON6 To operate the fundamental concepts of modern physics in the field of nanotechnology, non- Newtonian fluids and energy production.
ON9 To operate information in the field of modern low-temperature systems and research activities.

Prerequisites
Bachelor

Postrequisites
Final examination

Medical dosimetry

Discipline cycle	Profiling discipline
Discipline component	Electives
SubjectID	28388 (3010708)
Course	2
Term	1
Credits count	5
Lections	15hours
Practical and seminar classes	30hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline
In this discipline, the field of ionizing radiation and the radiation dose are considered. The physical foundations of photon radiation dosimetry are given. The design feature and the principle of operation of ionization and semiconductor dosimetric detectors, as well as other methods of dosimetry are studied. The issues of dosimetry of charged and uncharged particles and dosimetry of incorporated radionuclides are considered. The main methods of protection against ionizing radiation in medicine are given.

Purpose of studying of the discipline
Mastering of modern professional knowledge in the field of applied nuclear physics, which are the basis for solving the problems of dosimetry of ionizing radiations for solving problems of professional activity.

Learning Outcomes
ON7 To operate with the fundamental concepts of modern physics in the field of visualization methods and nuclear-physical methods of diagnosis and therapy.
ON10 To operate information in the field of modern ionizing medical systems and research activities.

Prerequisites
Bachelor

Postrequisites
Final examination

Medical materials science

Discipline cycle	Profiling discipline
Discipline component	Electives
SubjectID	28395 (3010715)
Course	2
Term	1
Credits count	5
Lections	15hours
Practical and seminar classes	30hours

Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline
In this course, the main issues of materials science, as applied to medicine, are considered. The analysis of the basic properties of conductive, semiconductor and dielectric materials and the features of their application in medicine is given. The requirements for materials intended for biomedical use and endoprosthetics are given. The compatibility of various materials with biological media during prosthetics and the stability of functional properties during sterilization treatment are considered.

Purpose of studying of the discipline
Formation of fundamental principles in matters of medical materials science.

Learning Outcomes
ON10 To operate information in the field of modern ionizing medical systems and research activities.

Prerequisites
Bachelor

Postrequisites
Final examination

The research work of a student, including an internship and the implementation of a masters thesis II

Discipline cycle	Profiling discipline
Discipline component	University component
SubjectID	28390 (3010711)
Course	2
Term	1
Credits count	4
The research work	120hours
Total	120hours
Knowledge control form	Total mark on practice

Short description of discipline
Research work develops the ability to independently carry out activities in the field of education and science related to solving complex professional tasks in innovative conditions, ensuring the development of professional research thinking of undergraduates, forming a clear understanding of their main professional tasks, ways to solve them, conducting bibliographic work with the involvement of modern information technologies.

Purpose of studying of the discipline
Preparation of a master`s student for independent research work aimed at writing and defending a master`s thesis.

Learning Outcomes
ON2 To form the strategy and structure of the organization of scientific research and physico- mathematical modeling of nuclear facilities.
ON3 To form the strategy and structure of the organization of scientific research and computer-aided design in low-potential energy.
ON4 To form the strategy and structure of the organization of scientific research in the field of measurement of ionizing radiation and mathematical methods of analysis for biomedical research.

Prerequisites
The research work of a student, including an internship and the implementation of a master s thesis I

Postrequisites
The research work of a student, including an internship and the implementation of a masters thesis III

Application of accelerators in medicine and industry

Discipline cycle	Profiling discipline
Discipline component	Electives
SubjectID	28382 (3010703)
Course	2
Term	1
Credits count	5
Lections	30hours
Practical and seminar classes	15hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline
This course covers the basic concepts in the field of physics and accelerator techniques. The classification and types of accelerators are given. General information about the acceleration of charged particles is given. The principle of operation and design features of direct-acting accelerators, linear induction accelerators and cyclic accelerators are considered. Accumulators and the method of counter beams are considered. The main issues of operation and maintenance of accelerators are examined.

Purpose of studying of the discipline

The formation of knowledge that should be possessed by a specialist engaged in the operation of accelerators and their use in solving scientific or applied problems.

Learning Outcomes

ON4 To form the strategy and structure of the organization of scientific research in the field of measurement of ionizing radiation and mathematical methods of analysis for biomedical research.
ON10 To operate information in the field of modern ionizing medical systems and research activities.

Prerequisites

Bachelor

Postrequisites

Final examination

Principles of radiation diagnostics and therapy

Discipline cycle	Profiling discipline
Discipline component	Electives
SubjectID	28397 (3010722)
Course	2
Term	1
Credits count	5
Lections	15hours
Practical and seminar classes	15hours
Laboratory works	15hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline

The course examines general and specific issues of radiation diagnostics and radiology. The physicotechnical and biological foundations of radiation therapy and the work of the radiation therapy department are considered. The existing sources of ionizing radiation, clinical dosimetry and means of providing radiation protection are given. Indications and contraindications to radiation therapy, methods and planning of radiation therapy, as well as radiation reactions and injuries are given.

Purpose of studying of the discipline

Formation of knowledge, abilities and skills on modern issues of radiation diagnosis and therapy, the study of the main methods of radiation diagnosis and therapy.

Learning Outcomes

ON4 To form the strategy and structure of the organization of scientific research in the field of measurement of ionizing radiation and mathematical methods of analysis for biomedical research.
ON7 To operate with the fundamental concepts of modern physics in the field of visualization methods and nuclear-physical methods of diagnosis and therapy.
ON10 To operate information in the field of modern ionizing medical systems and research activities.

Prerequisites

Bachelor

Postrequisites

Final examination

Theory of calculation of refrigeration systems

Discipline cycle	Profiling discipline
Discipline component	Electives
SubjectID	28392 (3010714)
Course	2
Term	1
Credits count	5
Lections	15hours
Practical and seminar classes	30hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline

This course discusses the general provisions on the design of the design calculation of refrigeration systems. Methods of calculation of compressor units of single-stage, two-stage and cascade compression, as well as compound schemes are analyzed. Graphoanalytical methods of calculation of high and low pressure heat exchangers and analysis of efficiency and prospects for the development of structures are given. The analysis of the operation of refrigeration systems by mathematical modeling methods is considered.

Purpose of studying of the discipline

Formation of students` calculation skills in designing and analyzing the efficiency of refrigeration systems.

Learning Outcomes

ON3 To form the strategy and structure of the organization of scientific research and computer-aided design in low-potential energy.

ON9 To operate information in the field of modern low-temperature systems and research activities.

Prerequisites

Bachelor

Postrequisites

Final examination

Using heat and gas refrigeration machines

Discipline cycle	Profiling discipline
Discipline component	Electives
SubjectID	28385 (3010705)
Course	2
Term	1
Credits count	5
Lections	15hours
Practical and seminar classes	30hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline

Theoretical and actual cycles of gas refrigerating machines are considered in this discipline. The design of gas refrigerating machines with expanders and gas refrigerating machines with vortex tubes is given. The main provisions of the theory of thermoelectric refrigerating machines are given. The principle of operation, theoretical and actual processes of the steam ejector machine are considered. The principle of operation of the absorption refrigerating machine and the analysis of actual processes are given.

Purpose of studying of the discipline

The purpose of this course is to study the basics of working processes and the theory of heat-using and gas refrigeration machines, the design of their elements and the machine as a whole, as well as the assimilation of modern methods and calculation and design that ensure economical production and efficient operation.

Learning Outcomes

ON3 To form the strategy and structure of the organization of scientific research and computer-aided design in low-potential energy.
ON9 To operate information in the field of modern low-temperature systems and research activities.

Prerequisites

Bachelor

Postrequisites

Final examination

Plasma physics and thermonuclear reactors

Discipline cycle	Profiling discipline
Discipline component	Electives
SubjectID	28383 (3010704)
Course	2
Term	1
Credits count	5
Lections	15hours
Practical and seminar classes	30hours
Independent work of a student under the guidance of a teacher	35hours
Independent work of the student	70hours
Total	150hours
Knowledge control form	Examination

Short description of discipline

This course examines the current state and prospects for the development of thermonuclear energy. The basic concept of plasma and plasma retention is given. Radiation losses from the plasma and plasma parameters in the fusion reactor are considered. The design and economic analysis of the construction of a D-T reactor is given. Tokamaks, probcotrons, linear and toroidal theta pinches, laser fusion and promising designs of fusion plants are considered.

Purpose of studying of the discipline

Theoretical and practical preparation of undergraduates for work related to calculations, design and operation of facilities operating on the basis of thermonuclear fusion.

Learning Outcomes

ON2 To form the strategy and structure of the organization of scientific research and physico- mathematical modeling of nuclear facilities.
ON8 To operate information in the field of modern nuclear power plants, thermonuclear energy in matters of their safe operation and research activities.

Prerequisites

Bachelor

Postrequisites

Final examination

Research practice

Discipline cycle	Profiling discipline
Discipline component	University component
SubjectID	28280 (3010709)
Course	2
Term	2
Credits count	13
Working practice	390hours
Total	390hours
Knowledge control form	Total mark on practice

Short description of discipline

The research practice of the undergraduate is conducted in order to familiarize with the latest theoretical, methodological and technological achievements of domestic and foreign science, modern methods of scientific research, processing and interpretation of experimental data and their application in further activities

Purpose of studying of the discipline

Formation of students` skills of conducting research work within the framework of a master`s thesis.

Learning Outcomes

ON2 To form the strategy and structure of the organization of scientific research and physico- mathematical modeling of nuclear facilities.
ON3 To form the strategy and structure of the organization of scientific research and computer-aided design in low-potential energy.
ON4 To form the strategy and structure of the organization of scientific research in the field of measurement of ionizing radiation and mathematical methods of analysis for biomedical research.

Prerequisites

Basic and profile disciplines of the EP

Postrequisites

Final examination

The research work of a student, including an internship and the implementation of a masters thesis III

Discipline cycle	Profiling discipline
Discipline component	University component
SubjectID	28281 (3010712)
Course	2
Term	2
Credits count	9
The research work	270hours
Total	270hours
Knowledge control form	Total mark on practice

Short description of discipline

Research work develops the ability to independently carry out activities in the field of education and science related to solving complex professional tasks in innovative conditions, ensuring the development of professional research thinking of undergraduates, forming a clear understanding of their main professional tasks, ways to solve them, conducting bibliographic work with the involvement of modern information technologies.

Purpose of studying of the discipline

Preparation of a master`s student for independent research work aimed at writing and defending a master`s thesis.

Learning Outcomes

ON2 To form the strategy and structure of the organization of scientific research and physico- mathematical modeling of nuclear facilities.
ON3 To form the strategy and structure of the organization of scientific research and computer-aided design in low-potential energy.
ON4 To form the strategy and structure of the organization of scientific research in the field of measurement of ionizing radiation and mathematical methods of analysis for biomedical research.

Prerequisites

The research work of a student, including an internship and the implementation of a masters thesis II

Postrequisites

Final examination

Final assessment

Master`s dissertation

Credits count	8

4.Summary table on the scope of the educational program

«7M05302 - Technical physics»

Name of discipline	Cycle/ Component	Term	Number of credits	Total hours	Lec	SPL	LC	IWST	IWS	Knowledge control form
Sociolinguistic and scientific-pedagogical activity										
Foreign language (professional)	BS/US	1	3	90		30		20	40	Examination
History and philosophy of science	BS/US	1	5	150	15	30		35	70	Examination
Tertiary education	BS/US	1	3	90	15	15		20	40	Examination
Psychology of management	BS/US	1	3	90	15	15		20	40	Examination
Pedagogical practice	BS/US	3	6	180						Total mark on practice
Organization of scientific research in technical physics										
Scientific research methodology	BS/CCh	1	5	150	15	30		35	70	Examination
Methods of measurement of ionizing radiation and the properties of nuclear materials	BS/CCh	1	5	150	15	30		35	70	Examination
Methods of processing signals and images in medicine	BS/CCh	1	5	150	15	15	15	35	70	Examination
Organization and planning of scientific research	BS/CCh	1	5	150	15	30		35	70	Examination
The basic principles of the design of instruments and equipment	BS/CCh	1	5	150	15	30		35	70	Examination
Basics of CAD low potential energy	BS/CCh	1	5	150	15	30		35	70	Examination
Theory and Techniques of a scientific experiment	BS/CCh	1	5	150	15	15	15	35	70	Examination
Theory and technique of heating experiment	BS/CCh	1	5	150	15	15	15	35	70	Examination
Physics and mathematics modeling of nuclear power plants	BS/CCh	1	5	150	15	30		35	70	Examination
Fundamental concepts of modern physics										
Selected chapters of modern physics	AS/US	2	5	150	30	15		35	70	Examination
Magnetic resonance methods	AS/CCh	2	5	150	30	15		35	70	Examination
Mechanics of continuous media	AS/CCh	2	5	150	15	30		35	70	Examination
The research work of a student, including an internship and the implementation of a master s thesis I	AS/US	2	11	330						Total mark on practice
Basic principles of modern physics (in English)	AS/CCh	2	5	150	30	15		35	70	Examination
Basics of cogeneration	AS/CCh	2	5	150	15	30		35	70	Examination
Basics of nanotechnology	AS/CCh	2	5	150	30	15		35	70	Examination
Fundamentals of nuclear physics in the application to medicine	AS/CCh	2	5	150	15	30		35	70	Examination
Modern methods of energy conversion	AS/CCh	2	5	150	15	30		35	70	Examination
Physics of rheological fluids	AS/CCh	2	5	150	15	30		35	70	Examination

Physical methods of visualization	AS/CCh	2	5	150	15	30		35	70	Examination
Modern directions of technical physics										
Perspectives and heat physics problems of heat refrigerants technique	AS/CCh	3	5	150	30	15		35	70	Examination
Atomic power stations	AS/CCh	3	5	150	15	30		35	70	Examination
Safe operation of nuclear power plants	AS/CCh	3	5	150	30	15		35	70	Examination
Hydrogen energetics	AS/CCh	3	5	150	15	30		35	70	Examination
Cryogenic technique	AS/CCh	3	5	150	15	30		35	70	Examination
Medical dosimetry	AS/CCh	3	5	150	15	30		35	70	Examination
Medical materials science	AS/CCh	3	5	150	15	30		35	70	Examination
The research work of a student, including an internship and the implementation of a masters thesis II	AS/US	3	4	120						Total mark on practice
Application of accelerators in medicine and industry	AS/CCh	3	5	150	30	15		35	70	Examination
Principles of radiation diagnostics and therapy	AS/CCh	3	5	150	15	15	15	35	70	Examination
Theory of calculation of refrigeration systems	AS/CCh	3	5	150	15	30		35	70	Examination
Using heat and gas refrigeration machines	AS/CCh	3	5	150	15	30		35	70	Examination
Plasma physics and thermonuclear reactors	AS/CCh	3	5	150	15	30		35	70	Examination
Research practice	AS/US	4	13	390						Total mark on practice
The research work of a student, including an internship and the implementation of a masters thesis III	AS/US	4	9	270						Total mark on practice
Final assessment										
Master`s dissertation		4	8	240						