CATALOG OF ELECTIVE DISCIPLINES

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)

set of 2024

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Developed
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Scientific research methodology

Discipline cycle	Basic disciplines
Course	1
Credits count	5
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.

Learning outcomes by discipline
- apply general scientific research methods;
- analyze research results;
- formulate results of scientific research.

Prerequisites
Bachelor

Postrequisites
Final examination

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

Discipline cycle	Basic disciplines
Course	1
Credits count	5
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.

Learning outcomes by discipline
- describe the categories and principle of classification of nuclear materials, physical foundations of calorimetric, gamma-spectroscopic, mass-spectroscopic and other analyzes of nuclear materials;
- to understand the basic processes of interaction of charged particles, neutrons and photons with matter, the characteristics of the field of ionizing radiation and their units of measurement;
- apply methods to reduce the variance of estimates of functionals in statistical modeling of particle trajectories;
- to draw up algorithms and programs for calculating the characteristics of the radiation field in media of various compositions;
- to use software packages for calculating the fields of ionizing radiation;
- to use the Monte Carlo method in the problems of radiation physics.

Prerequisites
Bachelor

Postrequisites
Final examination

Methods of processing signals and images in medicine

Discipline cycle	Basic disciplines
Course	1
Credits count	5
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.
Learning outcomes by discipline
- describe the properties of a biological object;
- choose methods of manipulating images;
- to formulate medical and technical requirements for medical measuring devices;
- evaluate the quality of medical images;
- approximate biological signals;
- analyze biological noise.
Prerequisites
Bachelor
Postrequisites
Final examination

Organization and planning of scientific research

Discipline cycle	Basic disciplines
Course	1
Credits count	5
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.
Learning outcomes by discipline
- describes the methodology and methodology of scientific research;
- defends the formulated goal, objectives and conclusions of scientific research;
- compares the results of experiments with theoretical assumptions;
- uses various methods for processing measurement results and estimating errors.
Prerequisites
Bachelor
Postrequisites
Final examination

The basic principles of the design of instruments and equipment

Discipline cycle	Basic disciplines
Course	1
Credits count	5
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.
Learning outcomes by discipline
- to formulate the terms of reference;

- develop requirements for the product;
- to structure the performance properties;
- evaluate the reliability of devices and equipment.

Prerequisites
Bachelor

Postrequisites
Final examination

Basics of CAD low potential energy

Discipline cycle	Basic disciplines
Course	1
Credits count	5
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.

Learning outcomes by discipline
- demonstrate the basics of mathematical modeling and optimization of simulated objects;
- to make material and thermal balances of processes;
- build mathematical models of heat exchangers of refrigeration units;
- to compare the optimal temperature conditions of operation of refrigeration units.

Prerequisites
Bachelor

Postrequisites
Final examination

Theory and Techniques of a scientific experiment

Discipline cycle	Basic disciplines
Course	1
Credits count	5
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.

Learning outcomes by discipline
- explain the role of technical measurements and experimental studies in the development of science and technology;
- to draw up measuring schemes in accordance with the objectives of the research;
- choose measurement tools based on the analysis of the requirements for the accuracy of experimental results;
- to search for optimal conditions for conducting experiments;
- Take the number and condition for the experiments necessary to achieve the goal.

Prerequisites
Bachelor

Postrequisites
Final examination

Theory and technique of heating experiment

Discipline cycle	Basic disciplines
Course	1
Credits count	5

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.

Learning outcomes by discipline
- apply the methods and means of heat engineering research within the framework of the educational program;
- to draw up a plan of experimental research;
- draw up measuring schemes in accordance with the objectives of the research.

Prerequisites
Bachelor

Postrequisites
Final examination

Physics and mathematics modeling of nuclear power plants

Discipline cycle	Basic disciplines
Course	1
Credits count	5
Knowledge control form	Examination

Short description of discipline
In this course the main directions of application of electronic-computing machines in physical research are considered. The peculiarities of setting up a computational experiment are studied in detail. Numerical integration of functions of one variable and multiple integrals are given. Finite-difference methods for solving diffusion equations, as applied to nuclear reactors, are described. The methodology of modelling the motion of a particle in a force field is given. Characteristics of neutron-physical problems and an algorithm for modelling 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.

Learning outcomes by discipline
- to interpret the principles of using the finite difference method in solving the equations of convective heat transfer;
- choose the methods of interpolation and approximation used in the processing of experimental data;
- use mathematical software packages;
- to use methods for solving problems of heat transfer using computer technology.

Prerequisites
Bachelor

Postrequisites
Final examination

Magnetic resonance methods

Discipline cycle	Profiling discipline
Course	1
Credits count	5
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.

Learning outcomes by discipline
- describe the structure of the NMR spectrometer and the operation of its individual units;
- use the knowledge gained to carry out a physical experiment to study the structure and dynamics of molecular systems using the pulsed NMR method;
- work on an NMR spectrometer;
- to carry out a physical experiment using an NMR spectrometer.
Prerequisites
Bachelor
Postrequisites
Final examination

Mechanics of continuous media

Discipline cycle	Profiling discipline
Course	1
Credits count	5
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.
Learning outcomes by discipline
- to understand the basic principles of mechanics, dynamic laws, conservation laws, solved classical problems of mechanics;
- describe the main historical stages in the development of mechanics .;
- to use the general laws of mechanics to obtain particular laws.
Prerequisites
Bachelor
Postrequisites
Final examination

Basic principles of modern physics (in English)

Discipline cycle	Profiling discipline
Course	1
Credits count	5
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.
Learning outcomes by discipline
- describe the main properties of space-time and their relationship with conservation laws;
- understand the evolutionary and structural description of the physical system;
- apply the principles of symmetry in solving physical problems.
Prerequisites
Bachelor
Postrequisites
Final examination

Basics of cogeneration

Discipline cycle	Profiling discipline
Course	1
Credits count	5

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.

Learning outcomes by discipline
- to interpret the theoretical foundations of cogeneration;
- choose a suitable cogeneration unit;
- apply methods for calculating and operating cogeneration installations.

Prerequisites
Bachelor

Postrequisites
Final examination

Basics of nanotechnology

Discipline cycle	Profiling discipline
Course	1
Credits count	5
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.

Learning outcomes by discipline
- to interpret the main trends in the development of nanotechnology; describe the main methods using scanning probes;
- to use the general laws of nanotechnology to obtain particular laws;
- to solve applied problems;
- to apply the general laws of nanotechnology in solving applied problems.

Prerequisites
Bachelor

Postrequisites
Final examination

Fundamentals of nuclear physics in the application to medicine

Discipline cycle	Profiling discipline
Course	1
Credits count	5
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.

Learning outcomes by discipline

- to determine the properties of a biological object;
- use image acquisition methods;
- formulate medical and technical requirements for devices;
- evaluate the quality of images;
- analyze the visualization of bio-objects on scans;

Prerequisites

Bachelor

Postrequisites

Final examination

Modern methods of energy conversion

Discipline cycle	Profiling discipline
Course	1
Credits count	5
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.

Learning outcomes by discipline

- explain the physical foundations of modern methods for obtaining electrical and thermal energy;
- disclose the advantages and disadvantages of various ways to produce heat and electrical energy;
- demonstrates knowledge of the methods of calculating energy equipment.

Prerequisites

Bachelor

Postrequisites

Final examination

Physics of rheological fluids

Discipline cycle	Profiling discipline
Course	1
Credits count	5
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.

Learning outcomes by discipline

- interpret the classification of non-Newtonian fluids; present criteria that characterize the occurrence of turbulence in systems of non-Newtonian fluids;
- interpret the heat transfer characteristics of non-Newtonian fluids;
- calculate the flow of non-Newtonian fluids in pipes and channels;
- build velocity profiles in laminar and turbulent flows;
- to determine the characteristics of non-Newtonian fluids;
- to apply methods for solving applied problems in the field of physics of rheological fluids.

Prerequisites

Bachelor

Postrequisites

Final examination

Physical methods of visualization

Discipline cycle	Profiling discipline
Course	1
Credits count	5
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.

Learning outcomes by discipline
- describe the physical processes that underlie visualization systems; choose methods of visualization and image processing in medicine;
- explain the features and limitations of these methods;
- explain the principles of building hardware and software for image processing;
- use standard image processing programs;
- to interpret the results, which are obtained by different methods, from the point of view of the physical principles underlying visualization;
- work with equipment for applied purposes.

Prerequisites
Bachelor

Postrequisites
Final examination

Perspectives and heat physics problems of heat refrigerants technique

Discipline cycle	Profiling discipline
Course	2
Credits count	5
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.

Learning outcomes by discipline
- to describe the theoretical foundations of obtaining low and ultra-low temperatures, the main problems of keeping the low-temperature potential;
- apply modern approaches to obtaining high-temperature working environments;
- to carry out thermal calculations and analysis of the efficiency of heat and cold technologies;
- to optimize the temperature and time modes of the processes of impact on various material systems.

Prerequisites
Bachelor

Postrequisites
Final examination

Atomic power stations

Discipline cycle	Profiling discipline
Course	2
Credits count	5
Knowledge control form	Examination

Short description of discipline
This 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 WWPR 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.

Learning outcomes by discipline

- represent nuclear processes and kinetics of a nuclear reactor;
- describe the production of electrical and thermal energy in nuclear-fueled power plants;
- to carry out the calculation of thermal circuits of power plants and their main elements.

Prerequisites

Bachelor

Postrequisites

Final examination

Safety operation of nuclear power plants

Discipline cycle	Profiling discipline
Course	2
Credits count	5
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.

Learning outcomes by discipline

- to interpret the theoretical and practical foundations for the safe operation of nuclear power plants;
- to organize the planning of activities for technical security provision on the basis of state and international requirements;
- draw up the documents required by the safety management system;
- use the definition of priorities in the performance of maintenance and repair of nuclear power plants.

Prerequisites

Bachelor

Postrequisites

Final examination

Hydrogen energetics

Discipline cycle	Profiling discipline
Course	2
Credits count	5
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.

Learning outcomes by discipline

- describe the methods of obtaining, storing hydrogen;
- to apply the main directions of scientific research work in the field of hydrogen energy;
- compare different methods of hydrogen production;
- to show the prospects for the development of hydrogen energy.

Prerequisites

Bachelor

Postrequisites

Final examination

Cryogenic technique

Discipline cycle	Profiling discipline

Course	2
Credits count	5
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.

Learning outcomes by discipline
- to interpret the mechanism of the process and phenomena occurring in machines and apparatus of cryogenic technology;
- describe the structure and operation of the main most common designs of apparatuses and machines used in the separation of gas mixtures by the method of low-temperature rectification;
- to use the basic methods of calculating machines and apparatus of cryogenic technology;
- to use the methods of calculating the main most common processes and designs of machines and apparatus of cryogenic technology.

Prerequisites
Bachelor

Postrequisites
Final examination

Medical dosimetry

Discipline cycle	Profiling discipline
Course	2
Credits count	5
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.

Learning outcomes by discipline
- to interpret the physical laws underlying various dosimetry methods;
- to determine dosimetric values from various types of radiation;
- calculate the characteristics of the radiation field and dosimetric values using special computer programs.

Prerequisites
Bachelor

Postrequisites
Final examination

Medical materials science

Discipline cycle	Profiling discipline
Course	2
Credits count	5
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.

Learning outcomes by discipline
- describe the main issues of materials science;
- to understand the fundamental principles of the interaction of a living organism with various medical materials;

- analysis of the properties of biocompatible materials and medical devices;
- to apply the results and planning methods to solve practical problems in various fields of biomedical research.

Prerequisites
Bachelor

Postrequisites
Final examination

Application of accelerators in medicine and industry

Discipline cycle	Profiling discipline
Course	2
Credits count	5
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.

Learning outcomes by discipline
- to interpret the foundations of the theory of particle acceleration in cyclic and linear accelerators;
- describe the basic principles of construction and design, features of the operation of all existing types of accelerators;
- use packages of applied programs for modeling processes in accelerators;
- to use accelerators in scientific research and for applied purposes.

Prerequisites
Bachelor

Postrequisites
Final examination

Principles of radiation diagnostics and therapy

Discipline cycle	Profiling discipline
Course	2
Credits count	5
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.

Learning outcomes by discipline
- to interpret the principles of obtaining an image with radiation methods of diagnostics;
- describe the physical foundations of methods of radiation diagnostics;
- explain the basic principles of radiation therapy for tumors, indications and contraindications for its implementation;
- to choose modern methods of radiation treatment of malignant neoplasms and non-neoplastic diseases;
- explain deontological aspects in radiology;
- to determine methods for obtaining a high-quality diagnostic image;
- analyze the quality of the images obtained using various methods of radiation diagnostics;
- to identify the image of human organs and indicate their basic anatomical structures on the results of radiation examinations;
- use various methods of radiation diagnostics.

Prerequisites
Bachelor

Postrequisites
Final examination

Theory of calculation of refrigeration systems

Discipline cycle	Profiling discipline

Course	2
Credits count	5
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.

Learning outcomes by discipline
- adjust the parameters of the refrigeration unit;
- to design heat-insulating structures, taking into account the prevention of condensation of water vapor on the surface and inside fences, apparatus and pipelines;
-apply methods of calculation and analysis of compression units of refrigeration systems;
- master the methods of thermodynamic and technical and economic analysis to assess the efficiency of refrigeration systems and installations;
- analyze the operation of refrigeration systems.

Prerequisites
Bachelor

Postrequisites
Final examination

Using heat and gas refrigeration machines

Discipline cycle	Profiling discipline
Course	2
Credits count	5
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.

Learning outcomes by discipline
- describe the general foundations of the theory of thermodynamic processes of compression and expansion of gases;
- perform calculations and explain the principles of designing elements, assemblies and parts of refrigeration machines, as well as the principles of their aggregation and layout;
- draw up a technical assignment for design, make thermal and structural calculations of refrigerating machines and their elements;
- to make a technical and economic analysis in order to select the optimal version of the compressor, expander for the specific conditions of their operation;
- use thermal diagrams of working substances, as well as tables of thermodynamic and physical properties for them.

Prerequisites
Bachelor

Postrequisites
Final examination

Plasma physics and thermonuclear reactors

Discipline cycle	Profiling discipline
Course	2
Credits count	5
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.

Learning outcomes by discipline

- to interpret general information about plasma, equilibrium degree of ionization, Coulomb collisions;

- solve problems in plasma physics using basic laws and equations;

- to carry out a selection of schematic diagrams and technical features of the most important systems of installations.

Prerequisites

Bachelor

Postrequisites

Final examination