

## CATALOG OF ELECTIVE DISCIPLINES

**8D05 - Natural Sciences, Mathematics and Statistics**

(Code and classification of the field of education)

**8D053 - Physical and chemical sciences**

(Code and classification of the direction of training)

**0530**

(Code in the International Standard Classification of Education)

**D090 - D090 Physics**

(Code and classification of the educational program group)

**8D05302 - Technical Physics**

(Code and name of the educational program)

**Doctor of philosophy (PhD)**

(Level of preparation)

**set of 2024**

**Developed**

By the Academic Committee of the OP  
The head of the AK Kasymov Askar  
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**Reviewed**

At the meeting of the Commission on Academic Quality of the Faculty of Engineering and Technology  
Protocol № 3 15.01. 2024  
at a meeting of the Academic Quality Commission of the Research School of Physical and Chemical  
Sciences  
Recommended for approval by the University Academic Council  
Protocol No. 1 June 06, 2024

**Approved**

at a meeting of the University Academic Council by protocol No. 3 of January 16, 2024.

at a meeting of the University Academic Council by protocol No. 6 of June 18, 2024.

## Information and measuring systems and technologies in thermal physics

Discipline cycle	Profiling discipline
Course	1
Credits count	5
Knowledge control form	Examination

### Short description of discipline

*This course considers the use of modern information technologies for research in the field of thermal physics. The main packages of applied programs, which make it possible to build and study thermophysical models of key processes that take place in technical physics are studied. An important role is given to methods of mathematical optimization and processing of the obtained data. Along with this, the issues of automation of measurements in the course of scientific research are considered.*

### Purpose of studying of the discipline

*To form the core competencies in the field of using information technologies in thermal physics*

### Learning Outcomes

*ON7 Structure the information on the problems of thermophysics of materials in research activities.*

*ON9 Develop modern approaches to the issues of physical research using information technologies.*

### Learning outcomes by discipline

- to increase the level of use of information technologies and automation tools for solving management problems*
- to adapt packages of applied programs for solving urgent problems of thermal physics*
- use modern methods and means of obtaining, storing and processing information for scientific purposes*

### Prerequisites

*Masters degree course*

### Postrequisites

*Final examination*

## Methods and procedures for accounting and control of nuclear material

Discipline cycle	Profiling discipline
Course	1
Credits count	5
Knowledge control form	Examination

### Short description of discipline

*This course covers all important aspects related to the use of nuclear materials used in reactors for various purposes. All legal and technical issues of control and accounting of nuclear materials are studied. All technological processes associated with the movement, storage and inventory of nuclear materials are substantiated. Particular attention is paid to the technical means of working with nuclear materials and all accompanying documentation in accordance with the law.*

### Purpose of studying of the discipline

*Acquisition of knowledge that makes it possible to formulate and define the main provisions of the Law on the Use of Atomic Energy, which determine the essence of the requirements for accounting and control of nuclear materials at nuclear power plants, the main characteristics of the processes responsible for changing the amount of nuclear materials during the operation of nuclear fuel at nuclear power plants, the main characteristics of the components of the nuclear material balance zone at nuclear power plants, nuclear fuel flow patterns at NPPs, rules for maintaining material balance and operational accounting documents, methods, procedures and technical measuring instruments used for accounting and control of nuclear materials at NPPs, basic requirements for nuclear safety during physical start-up, reaching the minimum controlled level, and work in basic mode.*

### Learning Outcomes

*ON4 Form a scientific approach in the creation of new generation nuclear reactors.*

*ON5 Substantiate modern approaches to the issue of radiation safety within the framework of legislation and research activities.*

*ON8 Form a scientific approach in the field of radiation protection and control of nuclear materials.*

### Learning outcomes by discipline

- analyzes the categories and methods of control of materials related to nuclear;*
- organizes control, accounting and transportation of nuclear material;*
- applies legal principles of regulation in the field of accounting and control of nuclear material.*

### Prerequisites

*Masters degree course*

### Postrequisites

*Final examination*

## Theory of protection against ionizing radiation

Discipline cycle	Profiling discipline
Course	1
Credits count	5
Knowledge control form	Examination

### Short description of discipline

*The discipline considers the theoretical foundations of protection against various types of ionizing radiation. The main aspects of the impact of ionizing radiation on various materials are shown. Significant attention is paid to the effect of ionizing radiation on biological objects, especially on the human body. The substantiation of methods of protection against various types of radiation and the physical processes underlying them are considered in detail. Methods of dosimetric control at facilities operating nuclear materials are shown.*

### Purpose of studying of the discipline

*The purpose of the discipline "Theory and protection against ionizing radiation" is to acquire competencies in radiation dosimetry, calculation of optimization and design of protection against ionizing radiation of nuclear installations.*

## Learning Outcomes

ON4 Form a scientific approach in the creation of new generation nuclear reactors.

ON5 Substantiate modern approaches to the issue of radiation safety within the framework of legislation and research activities.

ON8 Form a scientific approach in the field of radiation protection and control of nuclear materials.

## Learning outcomes by discipline

- justify the methods and means of protection against ionizing radiation used
- evaluate methods for controlling the level of ionizing radiation
- modify the systems for neutralization and disposal of waste containing radioactive isotopes

## Prerequisites

Masters degree course

## Postrequisites

Final examination

## Thermophysical properties of materials

Discipline cycle	Profiling discipline
Course	1
Credits count	5
Knowledge control form	Examination

## Short description of discipline

This course considers methods for studying the thermophysical properties of materials in various states of aggregation. Methods for carrying out experimental and theoretical research in the field of thermal physics are shown. The principles underlying the determination of the thermophysical properties of substances and the main measuring instruments operating on the basis of these principles are studied. The relationship between the structure of substances and their thermophysical properties, as well as methods for predicting the properties of new materials, are considered.

## Purpose of studying of the discipline

To form knowledge about the mechanical, thermophysical, electrical, magnetic, optical properties of materials, to teach methods for determining thermophysical characteristics.

## Learning Outcomes

ON3 Interpret the physical essence of the phenomena and processes of heat transfer in scientific creativity and professional activities.

ON7 Structure the information on the problems of thermophysics of materials in research activities.

## Learning outcomes by discipline

- describe the main methods for determining the thermophysical properties of various materials and the patterns of their change;
- analyze the characteristics of mechanical properties;
- evaluate the thermal and electrical properties of various materials;
- use the results of the analysis of thermophysical properties in the methods of engineering calculation of processes and equipment.

## Prerequisites

Masters degree course

## Postrequisites

Final examination

## Thermodynamics of irreversible processes

Discipline cycle	Profiling discipline
Course	1
Credits count	5
Knowledge control form	Examination

## Short description of discipline

This course studies the theoretical foundations of the processes that take place in the absence of thermodynamic equilibrium in the system under consideration. Under such physical conditions, various kinds of non-equilibrium processes occur, associated with the transfer of one or another physical quantity. The main factors and criteria for the stability of the state of a thermodynamic system are considered. At the same time, important attention in the course is paid to studying the behavior of the system under the influence of external forces.

## Purpose of studying of the discipline

The purpose of this course is to study the main provisions and conclusions of the thermodynamics of irreversible processes, the formation of a creative approach to solving practical problems related to non-stationary, non-equilibrium flows of matter, energy and charge in physical systems.

## Learning Outcomes

ON3 Interpret the physical essence of the phenomena and processes of heat transfer in scientific creativity and professional activities.

ON6 Form a scientific approach in matters of statistical physics and thermodynamics of irreversible processes.

## Learning outcomes by discipline

- describe the balance equations that characterize the processes of transfer of mass, momentum, energy, charge, entropy, etc.
- to determine the flows and forces existing in non-equilibrium systems;
- calculate the thermodynamic properties of substances at given values of temperature and pressure based on reference data.

Formed competencies:

- forms a scientific approach to the theory of combustion and thermodynamics of irreversible processes.

## Prerequisites

Masters degree course

## Postrequisites

Final examination

## Nuclear fuel cycle of a new generation

Discipline cycle	Profiling discipline
Course	1
Credits count	5
Knowledge control form	Examination

### **Short description of discipline**

*This course is aimed at studying the problems associated with the implementation of the nuclear fuel cycle. The whole sequence of technological operations from fuel extraction to the final disposal of radioactive materials formed during the use of nuclear fuel is considered. From the point of view of the latest scientific developments, ways to improve the efficiency and safety of each stage of the nuclear fuel cycle are shown. The development prospects are considered taking into account the further development of the nuclear industry of the Republic of Kazakhstan.*

### **Purpose of studying of the discipline**

*To form the core competencies in the development of a new generation NFC, taking into account energy-saving technologies*

### **Learning Outcomes**

*ON3 Interpret the physical essence of the phenomena and processes of heat transfer in scientific creativity and professional activities.*

*ON4 Form a scientific approach in the creation of new generation nuclear reactors.*

*ON5 Substantiate modern approaches to the issue of radiation safety within the framework of legislation and research activities.*

*ON8 Form a scientific approach in the field of radiation protection and control of nuclear materials.*

### **Learning outcomes by discipline**

*- to form long-term goals and objectives of the NFC development in accordance with the development strategy of the nuclear industry*

*- to adapt calculation methods for the development of a new generation nuclear fuel cycle*

*- to carry out modeling and experimental research in the development of new NFC.*

### **Prerequisites**

*Masters degree course*

### **Postrequisites**

*Final examination*