

## 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)

**D089 - Chemistry**  
(Code and classification of the educational program group)

**8D05301 - Chemistry**  
(Code and name of the educational program)

**Doctor of philosophy (PhD)**  
(Level of preparation)

set of 2024

**Developed**

By the Academic Committee of the EP  
The head of the AK Kasymov Askar Bagdatovich  
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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 the meeting of the Commission on Academic Quality of the Research School of Food Engineering  
Recommended for approval by the University Academic Council  
Protocol № 1 06.06.2024

**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.

## Supramolecular structure of polymers

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

### Short description of discipline

The discipline forms idea of directions of research on supramolecular structure of polymers. The internal organization of polymer bodies studied. Models of SSP amorphous polymers discussed. The structure of cell of crystalline macromolecules, structural hierarchy, types common supramolecular organizations – lamellar, layered, fibrillar, dendritic, spherulites considered. Thermodynamics, kinetics of crystallization and melting described; factors influencing these processes; methods determining the structure.

### Purpose of studying of the discipline

The study of the main directions of the study of the supramolecular structure of polymers

### Learning Outcomes

ON4 Be motivated to develop and create new materials and composites with desired properties for different applications.

ON11 Definition of new branches of research, new problems in the field of chemical science

### Learning outcomes by discipline

- 1) Apply modern research methods to study the supramolecular structure of polymers
- 2) Demonstrate knowledge of the supramolecular organization of polymers
- 3) describe the physico-chemical basis of phase transitions of polymer bodies

### Prerequisites

Research methods Actual theoretical and applied aspects of chemistry

### Postrequisites

Final examination Research practice Doctoral student research work, including internship and doctoral dissertation III Doctoral student research work, including internship and doctoral dissertation IV Doctoral student research work, including internship and doctoral dissertation V Doctoral student research work, including internship and doctoral dissertation VI

## Polymer composites and materials

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

### Short description of discipline

The discipline forms knowledge in the field of polymer composite materials. The classification and characteristics of composites are considered. The structure and types of polymer matrices, types of fillers and intermediate semi-finished products, the technology of obtaining prepreps are studied. Methods of production and features of fiberglass, carbon fibers, textolites are discussed. The principles of creation, methods of improving the properties of PCM are described. Questions about heavy-duty, hybrid polymer composite materials and nanocomposites are covered.

### Purpose of studying of the discipline

Mastering the knowledge in the field of polymer composite materials

### Learning Outcomes

ON2 Analyze the latest achievements of modern chemical science, non-standard approaches, apply them to solve professional problems.

ON6 To show skills of self-preparation of the plan of scientific research, collection, processing and discussion of new scientific and applied results.

ON10 Own methodology, basic methods and techniques of scientific analysis in the field of chemistry for solving research and applied problems in the chemical industry

### Learning outcomes by discipline

- 1) Design new types of polymer materials
- 2) Describe the structure and properties of polymer matrices and prepreps
- 3) Propose methods for modifying polymer materials

### Prerequisites

Research methods Actual theoretical and applied aspects of chemistry

### Postrequisites

Final examination Research practice Doctoral student research work, including internship and doctoral dissertation III Doctoral student research work, including internship and doctoral dissertation IV Doctoral student research work, including internship and doctoral dissertation V Doctoral student research work, including internship and doctoral dissertation VI

## Modern problems of polymer materials

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

### Short description of discipline

The discipline studies problematic aspects of polymer materials science. Classification, ways of creation, properties of filled, unfilled PM are considered. The types, functions of fillers, principles of action of plasticizers, plasticizer, the value pigment, dye, antiprensa, stabilizers are studied. The problems destruction, deformation PCM, their strength, durability, difficulties in obtaining and processing them, ways to solve problematic issues are discussed.

### Purpose of studying of the discipline

The study of the main aspects of the development of polymer materials

### Learning Outcomes

ON1 To demonstrate in-depth knowledge and skills in priority areas of chemistry for solving research and applied problems.

ON4 Be motivated to develop and create new materials and composites with desired properties for different applications.

ON12 Apply innovative ideas and technologies in the professional field

### Learning outcomes by discipline

1) To reveal modern problems of polymer chemistry

2) Use the principles of polymer materials science to create structural materials

3) Create mechanically improved composite materials

### Prerequisites

Research methods Actual theoretical and applied aspects of chemistry

### Postrequisites

Final examination Research practice Doctoral student research work, including internship and doctoral dissertation III Doctoral student research work, including internship and doctoral dissertation IV Doctoral student research work, including internship and doctoral dissertation V Doctoral student research work, including internship and doctoral dissertation VI

## Fundamental and applied aspects of polymer hydrogels and cryogels

Discipline cycle Profiling discipline

Course 1

Credits count 5

Knowledge control form Examination

### Short description of discipline

The discipline studies the features of the gel-like state of a substance and the scope of their application. The structure, properties and methods of obtaining reversible and irreversible, physical and chemical polymer gels are considered. The structure of xerogels, lyogels, hydrogels and organogels, the principles of swelling of hydrogels are highlighted. Gel-forming materials and types of crosslinking agents are discussed. The nature, types and mechanisms of cryogel formation, research methods are studied.

### Purpose of studying of the discipline

The study of the main features of the gel state of matter and areas of their application

### Learning Outcomes

ON2 Analyze the latest achievements of modern chemical science, non-standard approaches, apply them to solve professional problems.

ON3 Demonstrate the ability to solve scientific and educational problems in the field of chemistry, possess modern technologies of higher school education, communication technologies.

### Learning outcomes by discipline

1) Use polymer gels for applied purposes

2) Describe the structure and properties of hydro- and cryogels

3) Synthesize new types of polymer gels

### Prerequisites

Research methods Actual theoretical and applied aspects of chemistry

### Postrequisites

Final examination Research practice Doctoral student research work, including internship and doctoral dissertation III Doctoral student research work, including internship and doctoral dissertation IV Doctoral student research work, including internship and doctoral dissertation V Doctoral student research work, including internship and doctoral dissertation VI

## Chemistry of biologically active substances

Discipline cycle Profiling discipline

Course 1

Credits count 5

Knowledge control form Examination

### Short description of discipline

The discipline examines the general patterns of chemical behavior of biologically active substances in the body, methods of studying their structure and metabolism. The specific chemical and biological properties, structural organization, methods of isolation and establishment of the structure of BAS are studied. Biologically active derivatives of hydrocarbons, carbohydrates, heterocyclic compounds, proteins, nucleic acids, lipids, alkaloids, terpenes are considered. The fields of application of bioactive compounds are described.

### Purpose of studying of the discipline

Deepening the knowledge of doctoral students in the field of reactivity, biological activity and the value of various natural and synthetic compounds, establishing the relationship between the structure and the biological activity of substances

### Learning Outcomes

ON1 To demonstrate in-depth knowledge and skills in priority areas of chemistry for solving research and applied problems.

ON4 Be motivated to develop and create new materials and composites with desired properties for different applications.

ON12 Apply innovative ideas and technologies in the professional field

### Learning outcomes by discipline

1) Describe the properties of biologically active substances

2) Carry out modification of biologically active substances

3) Determine the structure of BAS

### Prerequisites

Research methods Actual theoretical and applied aspects of chemistry

### Postrequisites

Final examination Research practice Doctoral student research work, including internship and doctoral dissertation III Doctoral student research work, including internship and doctoral dissertation IV Doctoral student research work, including internship and doctoral dissertation V Doctoral student research work, including internship and doctoral dissertation VI

## Polymer Destruction Chemistry

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

### Short description of discipline

The discipline considers the theoretical foundations of polymer degradation processes. The main ways of destruction of high-molecular compounds, the scope of their decomposition products are described. Destructive phenomena under the influence of UV rays, thermal, thermo-oxidative, chemical, mechanical destruction of polymer compounds, its negative consequences are studied. The mechanism, chemistry and kinetics of macromolecule decay, ways to reduce the destruction of hydrocarbons are considered. The types of stabilizers and the principles of their operation are described.

### Purpose of studying of the discipline

The study of the main ways of degradation of polymers and areas of application of their decomposition products

### Learning Outcomes

ON2 Analyze the latest achievements of modern chemical science, non-standard approaches, apply them to solve professional problems.

ON4 Be motivated to develop and create new materials and composites with desired properties for different applications.

ON9 To analyze, systematize, summarize the results of scientific research and present the results in the form of a doctoral dissertation

### Learning outcomes by discipline

- 1) Describe the mechanism of polymer destruction
- 2) Classify the types of destruction and its consequences
- 3) To carry out the selection of stabilizers that prevent destruction

### Prerequisites

Research methods Actual theoretical and applied aspects of chemistry

### Postrequisites

Final examination Research practice Doctoral student research work, including internship and doctoral dissertation III Doctoral student research work, including internship and doctoral dissertation IV Doctoral student research work, including internship and doctoral dissertation V Doctoral student research work, including internship and doctoral dissertation VI