



**Kazakh National Research Technical University named after K.I Satpayev**

**Geology and Oil-gas Business Institute named after K. Turyssov**

**Department of Chemical and Biochemical Engineering**

**Education Program**

## **CURRICULUM PROGRAM**

**"CHEMICAL PROCESSES AND PRODUCTION OF CHEMICAL MATERIALS"**

**PhD in Engineering and Engineering Business**

on the basis of the following specialties of the invalidated Qualifier of specialties:

6D072100 - Chemical technology of organic substances

1st Edition

in accordance with the State Educational Standard of Higher Education, 2018

**Almaty 2022**

**The program was compiled and signed by the parties:**

From KazNRTU named after K.Satpayev:

1. Head of the CaBE Department \_\_\_\_\_ Amitova A.A.
2. Director of the IGNGD named after K.Turysov \_\_\_\_\_ Syzdykov A.Kh.
3. Professor, Doctor of Chemical Sciences, CaBE \_\_\_\_\_ Selenova B.S.
4. Assoc.Professor of CaBE \_\_\_\_\_ Kerimkulova A.Zh.



**From employers:**

Director of LLP "Independent Center for expertise of Organic petroleum products"  
Kalmuratova A.A.

Approved at the meeting of the Academic Council of the Kazakh National Research Technical University named after K.I. Satpayev. Protocol No. 3 from 25.06.2021

**Qualification:**

Level 8 of the National Qualifications Framework:

8D07 Engineering, Manufacturing and Construction industries

8D071 Engineering and Engineering

**Professional competence:** organization of innovative activities in the field of modern technologies of synthesis and production of organic substances, organization and conduct of scientific and educational, experimental research and management activities in the field of chemical production.

**Brief description of the program:**

**The goal of the program:** the training of highly qualified specialists with fundamental educational, methodological and research training in the field of chemical technology of organic substances and their products that are competitive both within the country and on the international labor market.

**Types of employment.** PhD in engineering and engineering business can perform the following professional activities: educational (pedagogical); technological; social and pedagogical; research; organizational and managerial.

**The objects of professional activity** of doctoral graduates are the most advanced positions in higher and special educational institutions of the state and non-state sectors, research institutes and production corporations of the organic substances and materials production, domestic and foreign enterprises of chemical, petrochemical, gas and coal profile.

## EDUCATIONAL PROGRAM PASSPORT

### 1. Volume and content of the program

The educational program for the doctor of philosophy (PhD) has a scientific and pedagogical orientation and assumes fundamental educational, methodological and research preparation and profound studying of disciplines in the corresponding directions of Sciences for system of the higher and postgraduate education and the scientific sphere.

Doctoral educational programs in terms of professional training are developed on the basis of studying the experience of foreign universities and research centers that implement accredited training programs for doctors of PhD or doctors in the profile.

The content of the educational program profile doctoral established by the University itself.

The main criterion for the completion of the educational process for the preparation of doctors of philosophy (PhD) (doctor of profile) is the development of doctoral at least 180 academic credits, including all types of educational and scientific activities.

The period of study for doctoral degree is determined by the volume of mastered academic credits.

The educational program of doctoral studies for the degree of doctor of philosophy (PhD) or the profile is considered fully in case when the established volume of academic credits are learnt and the expected results of training are achieved.

Training in doctoral studies is carried out on the basis of master's degree programs in two directions:

- 1) scientific and pedagogical with term of training of not less than three years;
- 2) profile with a period of training of at least three years.

The content of the educational program "Chemical processes and production of chemical materials" involves in-depth study of the English language, specialization disciplines that provide a high level of professional training, in-depth training on the topic of dissertation research, interdisciplinary training, the formation of teaching skills in higher education. The program also as a mandatory component includes teaching practice, the implementation of research work of the doctoral student. For the development of the educational component of the educational program of doctoral studies and/or research doctoral student conducts field trips to foreign education and science institutions.

**The objectives of the program are:** harmonization of technology training of scientific and pedagogical specialists of higher qualification with international standards, as well as advancing the issues of their scientific, methodological, legal, financial and economic, personnel and material&technical support; implementation of the educational process in accordance with the principles of the international practice of training highly qualified scientific and pedagogical personnel, ensuring the implementation of an independent original scientific research, characterized by considerable relevance and practical significance.

## **2 Requirements for applicants**

The doctoral program accepts persons who have a master's degree and work experience of at least 1 (one) year or have completed training in residency.

Admission to the number of doctoral students is carried out by the admission commissions of Universities and scientific organizations on the basis of the entrance exam for groups of educational programs of doctoral studies and a certificate confirming foreign language proficiency in accordance with the common European competence (standards) of foreign language proficiency.

In admission case to universities doctoral students independently choose the educational program of the corresponding group educational programs.

Enrollment of persons for targeted training of doctors of philosophy (PhD) on the state educational order is carried out on a competitive basis.

The procedure for admission of citizens to doctoral studies is established in accordance with the "Standard rules for admission to training in educational organizations that implement educational programs of postgraduate education."

The formation of the contingent of doctoral students is carried out through the placement of the state educational order for the training of scientific and pedagogical personnel, as well as payment for training at the expense of citizens' own funds and other sources. The state shall ensure to citizens of the Republic of Kazakhstan the right to receive free postgraduate education on a competitive basis in accordance with the state educational order, if they receive this level of education for the first time.

At the "entrance" the doctoral student must have all the prerequisites necessary for the development of the relevant professional doctoral program. The list of necessary prerequisites is determined by the higher education institution independently.

In the absence of the necessary prerequisites, the doctoral student is allowed to master them on a fee basis. In this case, training in doctoral studies begins after the full

development of the doctoral prerequisites.

### **3 Requirements' for completion of studies and diploma**

Persons who have carried out the educational program of doctoral studies and defended their doctoral dissertation with a positive decision of the dissertation councils of the University, which has a special status or the Committee for control in the field of education and science of the Ministry of education and science of the Republic of Kazakhstan on the results of the examination, are awarded the degree of doctor of philosophy (PhD) or doctor in profile and issued a state diploma with the application (transcript).

Persons who have received a PhD degree, to deepen scientific knowledge, solve scientific and applied problems on a specialized topic performs a postdoctoral program or conduct research under the guidance of a leading scientist of the selected University.

#### **3.1 Requirements for key competencies of doctoral graduates:**

##### *1) have a performance:*

- on the main stages of development and paradigm shift in the evolution of science;
- on the subject, ideological and methodological specifics of natural (social, humanitarian, economic) Sciences;
- about scientific schools of the corresponding branch of knowledge, their theoretical and practical developments;
- on scientific concepts of world and Kazakhstan science in the relevant field;
- on the mechanism of implementation of scientific developments in practice;
- norms of interaction in the scientific community;
- pedagogical and scientific ethics of the researcher;

##### *2) know and understand:*

- current trends, trends and patterns of development of domestic science in the context of globalization and internationalization;
- methodology of scientific knowledge;
- achievements of world and Kazakhstan science in the relevant field;
- (to realize and accept) social responsibility of science and education;
- perfect foreign language for scientific communication and international cooperation;



3) *be able:*

- organize, plan and implement the research process;
- analyze, evaluate and compare different theoretical concepts in the field of research and draw conclusions;
- analyze and process information from various sources;
- to conduct independent scientific research, characterized by academic integrity, on the basis of modern theories and methods of analysis;
- generate your own new scientific ideas, communicate your knowledge and ideas to the scientific community, expanding the boundaries of scientific knowledge;
- choose and effectively use modern research methodology;
- plan and forecast your further professional development;

4) *have the skills:*

- critical analysis, evaluation and comparison of different scientific theories and ideas;
- analytical and experimental scientific activities;
- planning and forecasting the results of the study;
- public speaking and public speaking at international scientific forums, conferences and seminars;
- scientific writing and scientific communication;
- planning, coordination and implementation of research processes;
- systematic understanding of the field of study and demonstrate the quality and effectiveness of the chosen scientific methods;
- participation in scientific events, fundamental scientific domestic and international projects;
- leadership management and team management;
- responsible and creative attitude to scientific, scientific and pedagogical activity;
- carrying out patent search and experience in the transfer of scientific information using modern information and innovative technologies;
- protection of intellectual property rights to scientific discoveries and developments;
- free communication in a foreign language;

5) *be competent:*

- in the field of scientific and scientific-pedagogical activity in the conditions of rapid updating and growth of information flows;
- in conducting theoretical and experimental research;

- in the formulation and solution of theoretical and applied problems in scientific research;
- professional and comprehensive analysis of problems in the relevant field;
- in matters of interpersonal communication and human resource management;
- in matters of University training;
- in the examination of scientific projects and research;
- in ensuring continuous professional growth.

### **3.2 Requirements for RWD student program doctor of philosophy (PhD):**

- 1) compliance with the main problems of the educational program of doctoral studies, on which the doctoral dissertation is defended;
- 2) relevant and contains scientific novelty and practical significance;
- 3) based on modern theoretical, methodological and technological achievements of science and practice;
- 4) based on modern methods of data processing and interpretation using computer technology;
- 5) performed using modern methods of scientific research;
- 6) contain research (methodical, practical) sections on the basic protected provisions.

### **3.3 Requirements for the organization of practices:**

The practice is carried out in order to develop practical skills of scientific, scientific, pedagogical and professional activities.

The doctoral education program includes:

- 1) teaching and research practice - for students under the program of doctor of philosophy;
- 2) practical training – for students on the profile of doctoral program.

In the period of pedagogical practice, doctoral students, if necessary, are involved in conducting classes in bachelor's and master's degrees.

Research practice of the doctoral student is carried out in order to study the latest theoretical, methodological and technological achievements of domestic and foreign science, as well as the consolidation of practical skills, the use of modern methods of scientific research, processing and interpretation of experimental data in the dissertation research.






Practical training of doctoral students is carried out in order to consolidate the theoretical knowledge gained in the learning process, and improve the professional level.


The content of research and production practices is determined by the theme of the doctoral dissertation.

## 4 Curriculum of the educational program "Chemical Processes and Production of Chemical Materials"

4.1 Study duration: 3 years



MINISTRY OF EDUCATION AND SCIENCE OF THE REPUBLIC OF KAZAKHSTAN  
 KAZAKH NATIONAL RESEARCH TECHNICAL UNIVERSITY named after K.SATBAYEV



APPROVED  
 Chairman of the Management Board  
 Rectory of the Kazakh National Research Technical University named after K.Satbayev  
 A.M. Ergaliev  
 2022 y.

**CURRICULUM**  
 of Educational Program on enrollment for 2022-2023 academic year

Educational program SD07106 - "Basic processes of synthesis and production of new organic and polymer materials"  
 Group of educational programs D097 - "Chemical engineering and processes"

Discipline code	Name of discipline	Cycle	Total amount in credits	Total hours	Classroom amount technology	SIS (including TSS) in hours	Form of control	Academic degree: Doctor of Philosophy (PhD)										
								Allocation of face-to-face training based on courses and semesters										
								1 course		2 course		3 course						
1 semester	2 semester	3 semester	4 semester	5 semester	6 semester	1 semester	2 semester	3 semester	4 semester	5 semester	6 semester							
<b>CYCLE OF BASIC DISCIPLINES (BD)</b>																		
<b>M-1. Module of basic training (university component)</b>																		
MET302	Scientific research methods	BD UC	5	150	20/1	105	E	5										
LNG016	Academic writing	BD UC	5	150	0/0/5	105	E	5										
<b>component of choice</b>																		
BO032	Simulation and optimization of chemical engineering processes	BD CCH	5	150	20/1	105	E	5										
GHE06	Management of chemical technology processes																	
<b>CYCLE OF PROFILE DISCIPLINES (PD)</b>																		
<b>M-2. Module of professional activity (component of choice)</b>																		
BO023	Polymers with a complex of special properties	PD, CCH	5	150	20/1	105	E	5										
CHE14	GTL technology																	
BO034	Modern catalytic methods for the synthesis of polymers																	
CHE15	Green chemistry in the production of chemical substances and materials	PD, CCH	5	150	20/1	105	E	5										
<b>M-3. Practice-oriented module</b>																		
AA030	Professional practice	BD UC	10							10								
AA035	Research practice	PD UC	10								10							
<b>M-4. Experimental research module</b>																		
AA036	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWDS UC	5						5									
AA047	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWDS UC	40							20	20							
AA036	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWDS UC	60								30	30						
AA048	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWDS UC	18														18	
<b>M-5. Module of final attestation</b>																		
ECA303	Writing and defending a doctoral dissertation	FA	12															12
Total based on UNIVERSITY:										30	20	30	30	30	30			
										90	60	60	60	60	60			

Cycle code	Cycles of disciplines	Number of credits for the entire period of study		
		university component (UC)	component of choice (CCH)	Total
BD	Cycle of basic disciplines	20	5	25
PD	Cycle of profile disciplines	10	10	20
	Total for theoretical training:	30	15	45
RWDS		123		123
FA	Final attestation	12		12
<b>TOTAL:</b>		<b>12</b>	<b>15</b>	<b>180</b>

Decision of the Academic Council of Kazntu named after K.Satbayev. Protocol No. 13 of 28.09.2022.

Decision of the Educational and Methodological Council of Kazntu named after K.Satbayev. Protocol No. 2 of 26.04.2022.

Decision of the Academic Council of the Institute: \_\_\_\_\_ of 20.12.2021.

Vice-Rector for Academic Affairs \_\_\_\_\_

Institute Director of GdGB \_\_\_\_\_

Head of the Department of Chemical and \_\_\_\_\_

Specialty Council representative from employers \_\_\_\_\_

Zhasikov B.A.

Synlyke A.H.

Anisova A.A.

Kalmeratova A.A.

## **5 Descriptors of level and scope of knowledge, skills and competences**

Descriptors of the third level within the Comprehensive framework of qualifications of the European higher education area (EHEA) reflect the learning outcomes that characterize the ability of the student:

- 1) demonstrate a systematic understanding of the field of study, skills and research methods used in the field of chemistry of organic compounds;
- 2) demonstrate the ability to think, design, implement and adapt an essential research process with a scientific approach;
- 3) contribute with their own original research to the expansion of the boundaries of the scientific field, which deserves publication at the national or international level;
- 4) critically analyze, evaluate and synthesize new and complex ideas;
- 5) communicate their knowledge and achievements to colleagues, the scientific community and the General public;
- 6) to promote, in the academic and professional context, the technological, social or cultural development of a knowledge-based society.

## **6 Supplement to the diploma according to the standard ECTS**

The application is developed according to the standards of the European Commission, the Council of Europe and UNESCO/CEPES. This document serves only for academic recognition and is not an official confirmation of the document on education. Without a diploma of higher education is not valid. The purpose of completing the European Annex is to provide sufficient data on the holder of the diploma, the qualification he / she obtained, the level of this qualification, the content of the training program, the results, the functional purpose of the qualification, as well as information on the national education system. The application model that will translate the estimates uses the European credit transfer or credit transfer system (ECTS).

The European diploma Supplement provides an opportunity to continue education in foreign universities, as well as to confirm the national higher education for foreign employers. When traveling abroad for professional recognition will require additional legalization of the diploma of education. The European diploma Supplement is completed in English upon individual request and is issued free of charge.

**CREDIT – 5**

**PREREQUISITE – Organic chemistry**

### **THE PURPOSE AND OBJECTIVES OF THE COURSE**

The main goal of the course is to give the future specialist a fundamental basis for the study of oil and petrochemical products. To acquaint students with the theoretical foundations for the construction of the basic physical concepts underlying modern methods of analysis of the structure and properties of hydrocarbons, allowing to carry out a reasoned prediction of the physical properties of petroleum products based on the chemical properties of the original oil.

Course objective: acquisition of knowledge necessary for effective use in the field of rapidly developing modern instrumental methods of research; possession of the fundamental foundations for the study of oil and petrochemical products necessary to solve research and practical problems in the professional field.

### **BRIEF DESCRIPTION OF THE COURSE**

In the course on "Modern instrumental methods of research" is a statement of the sections: the present state of the representations underlying physical and physico-chemical studies of organic matter; methodology of application of the main physical regularities inherent to the oil system for metrological purposes; the relationship between the chemical structure of hydrocarbons and their physico-chemical parameters; establishing details of the chemical structure of the obtained compounds on the basis of quantitative data on its physical properties; the solution of problems; practical use of tools, allowing to implement, debug, and run in practice all types of the studied algorithms; the principles of interpretation of the results obtained on the basis of data obtained by physical - chemical methods of research and the existing knowledge about the Association of the structure of oil and its individual fractions of their physical parameters; a comprehensive approach to selecting a method, apparatus and methodology of the study the hydrocarbon composition of the oil.

### **KNOWLEDGE AND SKILLS UPON COMPLETION OF THE COURSE**

The study of this discipline will allow the student to gain **knowledge** and develop the **skills** necessary for solving simple practical problems, to find tools sufficient for their research, to obtain numerical results in some standard situations. Knowledge can be used in the laboratory of chemical, environmental, petrochemical, gas and coal profile.

### **GREEN CHEMISTRY IN ORGANIC MATTER TECHNOLOGY**

**CODE – CHE242**

**CREDIT – 5**

**PREREQUISITE** – Organic chemistry

### **THE PURPOSE AND OBJECTIVES OF THE COURSE**

The main goal of the course is to give the future specialist a fundamental basis for the study of the principles of sustainable development of systems based on the rational use of natural resources.

### **BRIEF DESCRIPTION OF THE COURSE**

Aware of "Green chemistry technology of organic substances" is given a summary of the sections: Principles for sustainable systems. General concepts and definitions. Factors that determine the stability of the system. Basic principles of green chemistry. The criteria for the evaluation of chemical production. Characteristics of the processes of chemical production and oil refining, accompanied by environmental pollution. Analysis of the secondary processes of oil refining on the basis of the criteria of green chemistry and engineering. Analysis of water pollution by plant. Ways to reduce the volume of wastewater. Rational schemes of water supply and Sewerage at oil refineries. Resource-saving technologies in the chemical industry of organic substances.

### **KNOWLEDGE AND SKILLS UPON COMPLETION OF THE COURSE**

Know: current trends in the development of chemical engineering; the main factors determining the environmental friendliness of chemical processes, ways to prevent and / or reduce their harmful effects on the environment and humans.

Be able to: search for the physical and chemical characteristics of compounds, to calculate the criteria of chemical reactions and processes, to conduct a comprehensive analysis of environmental facilities for oil refining, production of organic substances.

Own: methods of criteria assessment of industrial processes, and their application in solving practical problems.

### **GTL TECHNOLOGIES**

**CODE** – CHE278

**CREDIT** – 5

**PREREQUISITE** – Organic chemistry

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### **THE PURPOSE AND OBJECTIVES OF THE COURSE**

The main purpose of the course – to acquaint students with the basic laws of chemical reactions in the production and processing of synthesis gas; solution of various



technological problems arising in the management of technological installations; properties of raw materials, products, catalysts used in the industry.

Course objectives: the discipline "GTL technologies" is intended for professional training of specialists in chemical technology of organic substances and petrochemicals. Mastering this course contributes to a deep understanding of the chemistry and technology of the  $C_1$  molecule, the technology of alternative synthetic fuels, the production of many chemical and petrochemical products based on GTL technology, the prospects of the GTL industry

### **BRIEF DESCRIPTION OF THE COURSE**

In the course of "GTL technologies" is the presentation of the sections: the Trend of development of gas chemistry. The role of the synthesis gas in the process gas chemistry. Biogas, biomass. The production of synthesis gas from biomass. Plasma thermal method for production of synthesis gas from coal. Processing of heavy oil residues to produce synthesis gas. Production of liquid hydrocarbons by utilization of low-pressure and flare associated gases of oil and gas fields. Characteristics of compressed air, the production technology of compressed air. Fischer-Tropsch Synthesis. Processing of synthesis gas into liquid fuels. Preparation of aldehydes and alcohols by oxosynthesis. Perspective directions of production of methanol. Three-phase methanol synthesis. Synthesis of dimethyl ether. Production of formic and acetic acids.

### **KNOWLEDGE AND SKILLS UPON COMPLETION OF THE COURSE**

- to apply in practice knowledge from the field of oil and gas processing and petrochemistry;
- to solve specific problems from various fields of chemistry used in the industry;
- to use the accumulated knowledge for the design and calculation of technological installations.

### **THE CALCULATION AND MODELING OF MASS TRANSFER PROCESSES AND APPARATUS**

**CODE - CHE 227**

**CREDIT - 5**

**PREREQUISITE** - Chemistry, physics, processes and devices of chemical technology, general chemical technology

### **PURPOSE AND TASKS OF THE COURSE**

The main goal of the course is that doctoral students in this discipline acquire skills for calculating the material and heat balances of mass transfer devices, basic dimensions,



equipment parameters and the ability to choose the type, from catalogs and to simulate the process.

### **BRIEF DESCRIPTION OF THE COURSE**

The basic laws of the process of interfacial mass transfer. The law of additivity of phase transfer to mass transfer. The average driving force of the process of mass transfer. The material balance of mass transfer processes. Equilibrium systems. The principal device of rectification columns. Determining the number of theoretical plates graphically. Calculation of the number of plates at the working reflux (steam) number. Definition of reflux (steam) number. Features of the calculation of complex columns. Packed and plate columns. Calculation of the main dimensions of the plate columns. Absorption and desorption. Calculate the number of theoretical plates in the absorber. Heat balance absorber. Calculation of the desorption process. Heat balance desorber. Extraction. The basics of calculating extractors. Triangular diagram and its basic properties. The main types of extractors. Adsorption. Methods of the adsorption process. Basics of calculating the adsorber.

### **KNOWLEDGE, SKILLS, SKILLS TO COMPLETE COURSE**

Doctoral candidate after mastering the program of this discipline should:

- know the basic concepts of mass transfer processes and devices and its simulations;
- The basis of the theory of mass transfer,
- The main provisions of the simulation.
- develop hardware-technological schemes;
- compile and calculate the material and heat balances of mass transfer processes and devices,
- determine their geometrical dimensions and model it.
- assess risks and determine measures to ensure the safety of technological processes;
- to participate in the modeling of technological processes, the improvement of technological equipment and the reconstruction of production;
- draw up technological and technical documentation for operation

### **MODERN PROBLEMS OF CHEMISTRY AND POLYMER TECHNOLOGY**

**CODE - CHE 312**

**CREDIT - 5**

**PREREQUISITE** - Organic chemistry, Chemistry and polymer physics

**PURPOSE AND TASKS OF THE COURSE** is the discipline-training of specialists capable of solving research and design problems in the development of methods for

obtaining new types of polymeric materials, as well as optimization and improvement of known processes.

**The tasks are** the formation of a system of knowledge on the choice of optimal parameters for the formation of a given structure and the required set of material properties, the selection of technological equipment, the study of the quality of polymer material, etc.; preparation for independent experimental and theoretical research, technological calculations in accordance with the needs of modern production and economy.

### **BRIEF DESCRIPTION**

Brief description the discipline focuses doctoral students on the development of technical and technological solutions for the design of the processes of obtaining polymer products, preparation of theses in the following areas: the study of the relationship between the chemical nature of the polymer, the composition of the polymer composition, conditions and method of production, structure, structure and properties of the polymer; improvement and development of new environmentally friendly and low-waste technologies for obtaining polymer materials. In the process of development of the educational program, the graduate acquires the ability and willingness to: apply knowledge of the basics of polymer processing technology; the ability to design technological processes of polymer processing; own approaches to the creation of composite polymer materials.

### **NANOMATERIALS AND NANOTECHNOLOGY OF ORGANIC CHEMISTRY**

**CODE - CHE 301**

**CREDITS - 5**

**PREREQUISITE** – Physics, Chemistry, mathematic.

### **PURPOSE AND OBJECTIVES OF THE COURSE**

The purpose of the discipline "Nanomaterials and Nanotechnology of Organic Chemistry" is to study the current state and some of the prospects in the field of new technology and materials. The development of the structural features of nanoparticles, giving the nanostructured material unusual characteristics that allow you to create new technologies for obtaining products with desired properties.

**Course objectives:** The acquisition of knowledge necessary for the possession of today's state and describe some of the prospects in the field of nanomaterials and nanotechnology. Outline the basic concepts of semiconductor, magnetic and molecular nanostructures, X-ray multilayer mirrors, fullerene-like and structural nanomaterials. Consider the use of nanostructures in organic chemistry and the emerging prospects in oil refining, etc. ;

possession of the fundamentals for the study of nanomaterials and nanotechnology, necessary to solve research and practical problems in the professional field.

### **BRIEF DESCRIPTION OF THE COURSE**

The course "Nanomaterials and Nanotechnology of Organic Chemistry" provides a summary of the sections: The history of the development of nanotechnology. Priority areas of nanotechnology. Basic scientific terms and definitions Nanotechnology development. Priority areas of nanotechnology. Varieties of nanomaterials: consolidated nanomaterials, nano-semiconductors, nanopolymers, nano-biomaterials, fullerenes and tubular nanostructures, catalysts, nanoporous materials, and supramolecular structures. Nanoparticles (nanopowders). The science of small objects (nanoscience). . The natural boundaries of the development of existing microelectronics. Quantum pits, wires and points. Creating nano-objects on the principles of "top-down" and "bottom-up." Fantastic nanotechnology opportunities. The main scientific terms and definitions (nanomaterials, nanotechnology, nanodiagnosics, nanosystem engineering). Fundamental problems of the nanosystems industry. The formation of solid-state nanoclusters. Solid state chemical reactions. Mechanochemical transformations. Shock-wave synthesis. Nanostructuring under pressure with shear. Nanostructuring by crystallization of amorphous structures. Compaction (consolidation) of nanoclusters

### **KNOWLEDGE AND SKILLS RECEIVED BY STUDENTS AFTER STUDYING OF THE COURSE**

The study of this discipline will allow the student to apply the course to learn about the features of the substance in the nanostructured state, about the role of interphase boundaries in shaping the properties of nano-objects, about the stability of nano-objects, kinetics and quasi-equilibrium of processes in nanosystems, etc. As part of special courses, students become truly competent specialists.

### **DEFENSE OF DOCTORAL DISSERTATION**

**CODE – ECA302**

**CREDIT - 12**

The purpose of the doctoral dissertation is to assess the scientific-theoretical and research-analytical level of the doctoral student, formed professional and managerial competencies, readiness for independent implementation of professional tasks and compliance of its preparation with the requirements of the professional standard and the educational program of doctoral studies.

### **BRIEF DESCRIPTION**

Doctoral dissertation is a scientific work of a doctoral student, which is an independent study, in which theoretical provisions are developed, the totality of which can be qualified as a new scientific achievement, or a scientific problem is solved, or scientifically substantiated technical, economic or technological solutions are presented, the introduction of which makes a significant contribution to the development of the country's economy.

Doctoral dissertation-the result of research / experimental research work of the doctoral student, conducted during the entire period of doctoral studies.

The defense of the doctoral dissertation is the final stage of the master's degree. Doctoral dissertation should meet the following requirements:

- The theme of the dissertation should be related to the priority directions of development of science and/or state programs or programs of fundamental or applied research.

- The content of the dissertation, goals and objectives, scientific results should strictly correspond to the topic of the dissertation.

- The thesis is carried out in compliance with the principles of independence, internal unity, scientific novelty, reliability and practical value.

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**Рецензия  
на образовательную программу PhD докторантуры  
«Химические процессы и производство  
химических материалов»**

Образовательная программа «Химические процессы и производство химических материалов» PhD докторантуры предполагает фундаментальную образовательную, методологическую и исследовательскую подготовку высококвалифицированных специалистов, обладающих глубокими научными знаниями и профессиональными педагогическими навыками, для химической и нефтехимической промышленности, сферы науки и образования.

Образовательная программа (ОП) «Химические процессы и производство химических материалов» квалификации «8М071 - Инженерия и инженерное дело» Национальной рамки квалификации, разработана на основе Государственного общеобязательного стандарта высшего образования Республики Казахстан. Содержание и структура ОП по направлению подготовки «8М071 – Инженерия и инженерное дело» отвечает основным требованиям стандарта и содержит следующую информацию: цели и задачи ОП, характеристику профессиональной деятельности выпускника, академические требования к поступающим, требования для завершения обучения, рабочий учебный план, дескрипторы уровня и объема знаний, умений, навыков.

Структура Учебного плана ОП «Химические процессы и производство химических материалов» логична и последовательна. Дисциплины учебного плана раскрывают сущность актуальных на сегодняшний день проблем. В программе предусмотрено углублённое изучение дисциплин по органической химии и химии углеводородных материалов, современным методам их исследования, а так же ряд специальных дисциплин, которые способствуют формированию управленческих навыков выпускников, таких как, разработка и организация безотходного производства, комплексной подход при решении научных проблем в области производства и переработки органических веществ и материалов с минимизацией вредного воздействия на окружающую среду, способность ориентироваться в больших объемах информации, действовать в условиях неопределённости. Эти качества позволяют выпускникам программы PhD докторантуры быть конкурентоспособными в современных условиях развития экономики страны.

Считаю, что образовательная программа «Химические процессы и производство химических материалов» PhD докторантуры отвечает потребностями рынка труда, задачам индустриально-инновационного развития страны и может быть рекомендована к внедрению в учебный процесс.

Директор ТОО "Независимый центр экспертизы нефтепродуктов "Organic"



А.А.Калмуратова