



ҚАЗАҚ ҰЛТТЫҚ ҚЫЗДАР ПЕДАГОГИКАЛЫҚ УНИВЕРСИТЕТІ  
ЖАРАТЫЛЫСТАНУ ИСНТИТУТЫ  
7М05302 – ХИМИЯ  
Элективті пәндер каталогы

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## 1 OPTIONAL COMPONENT OF THE CYCLE OF CORE COURSES

### *Component of choice 1*

**Course: Modern inorganic chemistry**

*Intensity of the Course:* 5 academic credits

**Module Code: АРМСн-2**

**Module Name: Actual problems of modern chemistry**

*Prerequisites:* ICh 1205 Inorganic chemistry

*Purpose:* Equipping undergraduates with theoretical knowledge about inorganic chemistry, teaching them to apply the knowledge gained in other areas of chemistry and practice.

*Short Description:* The place of modern inorganic chemistry in the system of sciences of the natural science cycle. The importance of inorganic chemistry for various fields of technology, medicine and agriculture. Periodic law, Periodic table of chemical elements: current state of the problem. The main features and tasks of modern inorganic chemistry: search, synthesis and design of new chemical compounds, creation of structural materials of the future.

*Learning Outcomes:*

*Learning Outcomes in EP (LOP)*

LOP3 - He has the skills to use modern instrumentation in the field of fine organic synthesis, elemental and spectral analysis, chromatography-mass spectrometry to solve specific research and application problems.

LOP8 - Conducts original research that expands the scope of existing knowledge.

*Learning Outcomes in Course (LOC)*

LOD 1 – Orientates in modern trends in the development of inorganic chemistry;

LOD 2 - Knows how to plan experiments depending on the task;

LOD 3 – Possesses the skills of working on modern equipment;

LOD 4 – Performs processing of the results of chemical experiments;

LOD 5 – Improves practical skills of working on modern equipment;

LOD 6 – Owns the methods of registration and processing of the results of chemical experiments;

LOD 7 - Uses the knowledge gained in practice.

*Post requisites:* HDChSK 5302 History and development of chemical science in Kazakhstan.

### *Component of choice 1*

**Course: Modern advances in inorganic chemistry**

*Intensity of the Course:* 5 academic credits

**Module Code: АРМСн-2**

**Module Name: Actual aspects modern chemistry**

*Prerequisites:* ICh 1205 Inorganic chemistry

*Purpose:* Study and master the knowledge gained by students in the field of chemistry, inorganic chemistry and organic chemistry.

*Short Description:* The place of modern inorganic chemistry in the system of sciences of the natural science cycle. The importance of inorganic chemistry for various fields of technology, medicine and agriculture. Periodic law, Periodic table of chemical elements: current state of the problem. The main features and tasks of modern inorganic chemistry: search, synthesis and design of new chemical compounds, creation of structural materials of the future.

*Learning Outcomes:*



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*Learning Outcomes in EP (LOP)*

LOP3 - He has the skills to use modern instrumentation in the field of fine organic synthesis, elemental and spectral analysis, chromatography-mass spectrometry to solve specific research and application problems.

LOP7 - Has research and digital skills.

*Learning Outcomes in Course (LOC)*

LOD 1 – Owns the methods of registration and processing of the results of chemical experiments;

LOD 2 - Knows how to plan experiments depending on the task;

LOD 3 – Possesses the skills of working on modern equipment;

LOD 4 – Uses the knowledge gained in practice;

LOD 5 – Improves practical skills of working on modern equipment;

LOD 6 – Performs processing of the results of chemical experiments;

LOD 7 – Oriented in modern trends in the development of inorganic chemistry.

*Post requisites:* FN 6305 Fundamentals of Nanotechnology, ASCh 6304.1 Aspects of Surface Chemistry

*Component of choice 2*

**Course: Applied foundations of modern organic chemistry**

*Intensity of the Course:* 5 academic credits

*Module Code:* **APMCh-2**

*Module Name:* Actual aspects modern chemistry

*Prerequisites:* SChOCh3206 Selected Chapters in Organic Chemistry, ChTOS 4302.2 Chemical Technology of Organic Substances

*Purpose:* Fundamental education of undergraduates in organic chemistry. Basic theoretical problems of organic chemistry, hydrocarbons, nomenclature, isomerism, basic classes.

*Short Description:* The current state of applied organic chemistry. Organic synthesis: main stages, patterns and development trends. Organic catalysis. Reactivity and catalysis, mechanisms of catalytic reactions. Computer synthesis of complex organic compounds, molecular design. Mathematical and computer modeling in organic chemistry. Chemistry of life processes. New in the chemistry of proteins and nucleic acids. Engineering enzymology. Green chemistry as a way to create waste-free industries.

*Learning Outcomes:*

*Learning Outcomes in EP (LOP)*

LOP4 - Capable of complex analysis and forming judgments about global environmental and economic problems and rational use of natural resources.

LOP8 - Conducts original research that expands the scope of existing knowledge.

*Learning Outcomes in Course (LOC)*

LOD 1 - The role of organic chemistry in the system of sciences and theoretical foundations of organic chemistry; LOD 2 - Adaptation of the acquired knowledge for solving specific problems related to professional activities; can independently work with educational and reference literature on organic chemistry;

LOD 3 – Theoretical concepts of organic chemistry, knowledge of the composition, structure and properties of organic substances - knows the representatives of the main classes of organic compounds;

LOD 4 – Mastering the basic methods of practical work in organic chemistry;

LOD 5 – Can apply basic knowledge of organic chemistry to practical problems;



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LOD 6 – Can implement the ideas of the basics of organic synthesis, physicochemical methods for the analysis of organic compounds;

LOD 7 – Place of organic chemistry in the system of sciences, mastered the theoretical foundations of organic chemistry.

*Post requisites:* MNTPhChA 5302 Methods of new technologies for physical and chemical analyzes

*Component of choice 2*

*Course:* **Heterocyclic compounds**

*Intensity of the Course:* 5 academic credits

*Module Code:* **APMCh-2**

*Module Name:* Actual aspects modern chemistry

*Prerequisites:* APMOCh 5205 Actual problems of modern organic chemistry

*Purpose:* The ring of heterocycles can contain elements other than carbon. Construction of many derivatives of furan, thiophene, pyrrole, pyridine, pyrimidine compounds; production methods, chemical properties, and the importance of natural derivatives.

*Short Description:* Classification of heterocyclic compounds. Five-membered heterocycles with one heteroatom. Five-membered heterocycles with two or more heteroatoms. Six-membered heterocycles with one heteroatom. Six and seven membered heterocycles with two heteroatoms. Bicyclic heterocycles. Nucleic acids. The structure and structure of nucleic acids. DNA (deoxyribonucleic acids). RNA (ribonucleic acids).

*Learning Outcomes:*

*Learning Outcomes in EP (LOP)*

LOP3 - He has the skills to use modern instrumentation in the field of fine organic synthesis, elemental and spectral analysis, chromatography-mass spectrometry to solve specific research and application problems.

LOP6 - Has an understanding of the system of fundamental chemical concepts and methodological aspects of chemistry, their role in the General professional training of chemists.

*Learning Outcomes in Course (LOC)*

LOD 1 - Studying the classification of heterocyclic compounds;

LOD 2 - Forms the properties of heterocyclic compounds in the chemical, electronic and spatial structure;

LOD 3 - Can handle organic substances (liquids, solids, flammable, toxic, aromatic);

LOD4 - Distinguishes between five-membered heterocycles with one heteroatom and five-membered heterocycles with two or more heteroatoms;

LOD 5 - Learns about the importance of natural products

LOD 6 - Can draw graphs and diagrams;

LOD 7 - Can process the results of laboratory experiments.

*Post requisites:* AC 2303 Analytical Chemistry, MMA 3233 Modern Methods of Analysis

*Component of choice 3*

*Course:* **Analytical chemistry of biological objects and drugs products**

*Intensity of the Course:* 5 academic credits

*Module Code:* **APMCh-2**

*Module Name:* Actual aspects modern chemistry

*Prerequisites:* AC 2303 Analytical Chemistry,



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*Purpose:* "Analytical chemistry of biological objects and medicines" is the development of professional skills of undergraduates in the study of the chemical composition of wildlife and medicines using modern methods of analysis of elements and materials, taking into account their specificity as objects of research, allowing to evaluate the processes of transformation and transfer. Biologically active substances and their metabolites in living organisms. At the same time, special attention is paid to practical skills with an emphasis on monitoring the reliability of the results obtained. During the course, undergraduates get acquainted with the theoretical parts of modern elementary and instrumental analysis of materials using inductively coupled plasma, capillary electrophoresis and high performance liquid chromatography and atomic emission spectrometry, based on basic knowledge of analytical chemistry. In practical classes, undergraduates master the methods of work and methodological techniques using these methods of analysis, the purpose of which is to determine the composition of micro- and macroelements, as well as organic substances and drugs in biosubstrates of humans and animals, including those on a plant basis.

*Short Description:* The content of the discipline includes questions, the development of professional skills in the study of the chemical composition of the animal world and medicines using modern methods of analysis of elements and materials, taking into account their characteristics, as objects of research, allowing to evaluate the processes of transformation and transfer.

*Learning Outcomes:*

*Learning Outcomes in EP (LOP)*

LOP4 - Capable of complex analysis and forming judgments about global environmental and economic problems and rational use of natural resources.

LOP5 - Possesses communication technologies, scientific rhetoric skills, and communication strategies.

*Learning Outcomes in Course (LOC)*

LOD 1 – Has an idea of the features of biological systems and drugs as objects of analysis.

LOD 2 -Can assess the possibility of using various methods of elemental and material analysis to study the chemical composition of biologically active substances.

LOD 3 - Knowledge and ability to apply methods for assessing the reliability of analysis results; owns methods of control, accounting and elimination of system errors due to the complex chemical composition and other features of the research object.

LOD 4 - The acquired skills of preparation for the analysis of the studied objects, depending on the applied instrumental method and research problem.

LOD 5 – He mastered the skills of practical application of modern instrumental methods for the analysis of elements (atomic emission spectrometry with inductively coupled plasma) and materials (capillary electrophoresis and high performance liquid chromatography) associated with the study of the composition of drugs and the effect of biologically active substances on living organisms.

LOD 6 – Understands the principles of organizing and managing scientific groups.

LOD7– Basics of business communication, interpersonal skills, the ability to work in a research team.

*Post requisites: no*

*Component of choice 3*

*Course: Modern analytical chemistry*

*Intensity of the Course: 5 academic credits*

*Module Code: АРМCh-2*

*Module Name: Actual aspects modern chemistry*



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*Prerequisites:* AC 2303 Analytical Chemistry,

*Purpose:* To acquaint undergraduates with the latest achievements in analytical chemistry, modern methods of detection, dissemination and determination. Provide the wizard with an understanding of the analytical methods used to quickly and fully assess the content of chemicals in an industrial and disaster area, as well as for eco-analytical monitoring of environmental objects.

*Short Description:* Introduction. Metrological foundations of chemical analysis. Types of chemical reactions and processes in analytical chemistry. Identification methods. Methods for isolation, separation and concentration. Chromatographic analysis methods. Gravimetric analysis method. Titrimetric methods of analysis. Kinetic methods of analysis. Electrochemical methods of analysis: potentiometry, coulometry, voltammetry, etc. Spectroscopic methods of analysis.

*Learning Outcomes:*

*Learning Outcomes in EP (LOP)*

LOP3 - He has the skills to use modern instrumentation in the field of fine organic synthesis, elemental and spectral analysis, chromatography-mass spectrometry to solve specific research and application problems.

LOP5 - Possesses communication technologies, scientific rhetoric skills, and communication strategies.

*Learning Outcomes in Course (LOC)*

LOD 1 – Knows the basics of modern analytical methods used to ensure chemical safety.

LOD 2 - Depending on the object of analysis and the task, you can choose the method of analysis, the conditions for the experiment.

LOD 3 – Acquisition of skills to work with modern equipment; mastered the methods of registration and processing of the results of chemical experiments in order to improve the practical skills of working with modern equipment, gain new knowledge related to the current state of the discipline, and apply the knowledge gained in practice.

LOD 4 – Understands the need for the safe handling of chemical materials, taking into account their physical and chemical properties, can assess the possible risks.

LOD 5 - Has a basic understanding of environmental chemistry, can assess the environmental risks of production.

LOD 6 - Can apply principles of green chemistry in chemical reaction design and process engineering.

LOD 7 - Understands and can obtain new knowledge using modern scientific methods and masters them at the level necessary to solve problems arising from the performance of professional functions that have a natural content.

*Post requisites:* MPhChR 2303 Methods of physical and chemical research

## 2 CYCLE OF PROFILING DISCIPLINE

*Component of choice 1*

*Course:* **Methods of IR, NMR, mass spectroscopic studies**

*Intensity of the Course:* 5 academic credits

*Module Code:* **MDCh-3**

*Module Name:* The main directions of modern chemistry

*Prerequisites:* FMI 3302 Physical research methods.

*Purpose:* The study and analysis of the interaction of substances with electromagnetic waves, the study and analysis of physical methods of infrared (IR), nuclear magnetic resonance (NMR), mass spectrometry.



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*Short Description:* High-resolution mass spectrometry and chromatography-mass spectrometry. Nuclear magnetic resonance spectroscopy. Vibrational spectroscopy. Electronic spectroscopy. Theoretical foundations of molecular optical spectroscopy. IR spectroscopy. Spectroscopy in the near, mid-IR region, prospects for use. Microwave spectroscopy. The theory of rotational spectra. Microwave spectrometers. <sup>1</sup>H nuclear magnetic resonance spectroscopy. The concept of correlation spectroscopy.

*Learning Outcomes:*

*Learning Outcomes in EP (LOP)*

LOP4 - Capable of complex analysis and forming judgments about global environmental and economic problems and rational use of natural resources.

LOP8 - Conducts original research that expands the scope of existing knowledge.

*Learning Outcomes in Course (LOC)*

LOD 1 – Can use mass spectrometry method.

LOD 2 - Can select the effective conditions of the physical method necessary for solving a practical problem.

LOD 3 - Can work using NMR spectroscopy.

LOD 4 - Can be operated using EPR spectroscopic analysis.

LOD 5 – Master the choice of methods for solving simple spectra.

LOD 6 - Master the basics of chromatographic methods.

LOD 7- Knows the basics of optical methods (IR, UV, X-ray analysis).

*Post requisites:* TFIMS 5303.1 Theoretical foundations of interaction in multicomponent systems.

*Component of choice 1*

**Course: Modern methods of physical and chemical analyzes**

*Intensity of the Course:* 5 academic credits

*Module Code:* **MDCh-3**

*Module Name:* The main directions of modern chemistry

*Prerequisites:* ICh 1205 Inorganic chemistry

*Purpose:* Equipping undergraduates with theoretical knowledge of inorganic chemistry, teach them to apply the knowledge gained in other areas of chemistry and practice.

*Short Description:* Mastering the methods of synthesis of some common and complex compounds. Synthesis in aqueous solution in air. Synthesis in aqueous solution in an inert atmosphere. Synthesis in aqueous solution using electric current. Synthesis in non-aqueous solution. High temperature synthesis. Low temperature synthesis. Description of methods for identification and analysis of impurities. Selection of equipment, starting materials and materials, assembly of a synthesis unit.

*Learning Outcomes:*

*Learning Outcomes in EP (LOP)*

LOP4 - Capable of complex analysis and forming judgments about global environmental and economic problems and rational use of natural resources.

LOP7 - Has research and digital skills.

LOP8 - Conducts original research that expands the scope of existing knowledge.

*Learning Outcomes in Course (LOC)*

LOD 1 – Develops the types of reactions used in inorganic synthesis;

LOD 2 - Mastering the methods of physical and chemical analysis of inorganic compounds;

LOD 3 – Knows the main types of inorganic materials used in production;

LOD4 – Organizes reaction methods in inorganic synthesis;



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LOD 5 – Organizes methods of reactions in inorganic synthesis;

LOD 6 – Knows how to work on inorganic synthesis;

LOD 7 – In practice, uses the methods of physicochemical analysis of inorganic compounds.

*Post requisites:* HDChSK 5302 History and development of chemical science in Kazakhstan.

*Component of choice 2*

*Course:* **Methods for the synthesis of inorganic compounds**

*Intensity of the Course:* 5 academic credits

*Module Code:* **MDCh-3**

*Module Name:* The main directions of modern chemistry

*Prerequisites:* RSTV 5207.1 Reactivity of solids.

*Purpose:* Many fundamental crystallochemical concepts are widely used in theoretical, experimental and applied chemistry and are an important part of modern chemistry.

*Short Description:* Mastering the methods of synthesis of some common and complex compounds. Synthesis in aqueous solution in air. Synthesis in aqueous solution in an inert atmosphere. Synthesis in aqueous solution using electric current. Synthesis in non-aqueous solution. High temperature synthesis. Low temperature synthesis. Description of methods for identification and analysis of impurities. Selection of equipment, starting materials and materials, assembly of a synthesis unit.

*Learning Outcomes:*

*Learning Outcomes in EP (LOP)*

LOP3 - He has the skills to use modern instrumentation in the field of fine organic synthesis, elemental and spectral analysis, chromatography-mass spectrometry to solve specific research and application problems.

LOP8 - Conducts original research that expands the scope of existing knowledge.

*Learning Outcomes in Course (LOC)*

LOD 1 – Knows the basics of nanotechnology.

LOD 2 - Predicts the stability and physicochemical properties of nanoobjects.

LOD3- Guides in the modern literature on nanotechnology.

LOD 4 - To independently set tasks for the creation or practical application of nanoobjects.

LOD 5 - He is oriented in the methods of obtaining and studying nanostructures.

LOD 6 - Understands the mechanism of physical and chemical dimensional effects.

LOD 7- Knows the specifics of the behavior of a substance in the nanometer size range.

*Post requisites:* MMPChA 5302 Modern methods of physical and chemical analysis

*Component of choice 2*

*Course:* **Nanotechnology**

*Intensity of the Course:* 5 academic credits

*Module Code:* **MDCh-3**

*Module Name:* The main directions of modern chemistry

*Prerequisites:* RSTV 5207.1 Reactivity of solids.

*Purpose:* Many fundamental crystallochemical concepts are widely used in theoretical, experimental and applied chemistry and are an important part of modern chemistry.

*Short Description:* Nanomaterials. Basic concepts and definitions. Carbon nanostructures. Fullerenes. Nanotubes. Consolidated nanomaterials. Nanocrystalline materials. Nanocomposites, nanoporous materials and magnetic nanoparticles. Molecular nanotechnology. Nanophotonics. Nanotechnology in ferroelectrics. Nanotechnology in the future everyday life. Nanoelectronics.





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*Learning Outcomes:*

*Learning Outcomes in EP (LOP)*

LOP3 - He has the skills to use modern instrumentation in the field of fine organic synthesis, elemental and spectral analysis, chromatography-mass spectrometry to solve specific research and application problems.

LOP4 - Capable of complex analysis and forming judgments about global environmental and economic problems and rational use of natural resources.

*Learning Outcomes in Course (LOC)*

LOD 1 – Knows the basics of nanotechnology.

LOD 2 - Predicts the stability and physicochemical properties of nanoobjects.

LOD3- Guides in the modern literature on nanotechnology.

LOD 4 - To independently set tasks for the creation or practical application of nanoobjects.

LOD 5 - He is oriented in the methods of obtaining and studying nanostructures.

LOD 6 - Understands the mechanism of physical and chemical dimensional effects.

LOD 7- Knows the specifics of the behavior of a substance in the nanometer size range.

*Post requisites:* MPhChA 5302 Modern methods of physical and chemical analysis

*Component of choice 3*

**Course: Wasteless technologies and ecology of the environment**

*Intensity of the Course:* 5 academic credits

**Module Code: MDCh-3**

*Module Name:* The main directions of modern chemistry

*Prerequisites:* ESD Environment and sustainable development

*Purpose:* Acquaintance with the basic concepts of the relationship between man and nature and the contradictions that arise in the process of meeting material needs and the laws of development of natural systems, the phenomena of natural resources and the peculiarities of their use.

*Short Description:* Rational use of natural resources. Waste-free technology. Waste-free technological system. The basic principles of creating waste-free industries. Complex use of raw materials. Creation of fundamentally new and improvement of existing technologies and schemes. Production waste disposal problems.

*Learning Outcomes:*

*Learning Outcomes in EP (LOP)*

LOP4 - Capable of complex analysis and forming judgments about global environmental and economic problems and rational use of natural resources.

LOP8 - Conducts original research that expands the scope of existing knowledge.

*Learning Outcomes in Course (LOC)*

LOD 1 – Can apply the knowledge gained and research methods in solving environmental problems.

LOD 2 - Acquires practical knowledge in the field of environmental pollution research.

LOD 3 - Learns to ensure environmental safety in areas with unfavorable environmental conditions.

LOD 4 - Mastering the theoretical foundations of environmental pollution, is able to find the achievements of environmental sciences.

LOD 5 – Can develop knowledge and practical skills necessary for future professional activities.

LOD 6 - Learns to use practice effectively. restoration of damaged natural ecosystems.

LOD 7 - Methods of non-waste technologies have been mastered.



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*Post requisites:* EE Ecology Environment

*Component of choice 3*

**Course: Modern advances in polymer synthesis**

*Intensity of the Course:* 5 academic credits

**Module Code: MDCh-3**

*Module Name:* The main directions of modern chemistry

*Prerequisites:* HVMS 4315 High Molecular Compound Chemistry

*Purpose:* Is the introduction of the basic methods for the synthesis of polymers, the reactivity of polymers, chemical reactions based on the processing and use of polymers, the properties and structure of the polymer during this reaction and the ability to use polymers with new properties, protecting polymers from harmful effects.

*Short Description:* Solution polymerization. Bulk polymerization. Polymerization in emulsion. Polymerization in aqueous dispersions. Chemical properties of acrylonitrile-based fiber-forming polymer. Chain polymerization. Methods for carrying out polymerization reactions. Step polymerization. Methods for carrying out polycondensation reactions. Copolymerization and copolycondensation. Special types of polymerization reactions.

*Learning Outcomes:*

*Learning Outcomes in EP (LOP)*

LOP5 - Possesses communication technologies, scientific rhetoric skills, and communication strategies.

LOP7 - Has research and digital skills.

*Learning Outcomes in Course (LOC)*

LOD 1 – ROD1– Has the competence to obtain various colloidal systems and describe their physical and chemical properties.

LOD2–Adsorption of electrolytes, electrokinetic phenomena in dispersed systems.

LOD 3 - Evaluates and draws conclusions from the design and conduct of experiments, the accuracy of the data obtained.

LOD 4 - Knows the classification of lyophilic coagulation and stability in dispersed systems, medium and coagulation pathway, emulsions and bubbles.

LOD 5 - Knows how to determine the degree of dispersion in dispersed systems.

LOD 6 - Chemical literature and references may be used.

LOD 7- Can apply the knowledge gained in practice.

*Post requisites:* TOVMS 5303.1 Theoretical foundations of interaction in multicomponent systems

*Component of choice 4*

**Course: Methods for the study of inorganic substances and materials**

*Intensity of the Course:* 5 academic credits

**Module Code: MDCh-3**

*Module Name:* The main directions of modern chemistry

*Prerequisites:* ICh 1205 Inorganic chemistry

*Purpose:* Provide undergraduates with theoretical knowledge about the methods of research of inorganic substances, teach them to apply their knowledge in other areas of chemistry and practice



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*Short Description:* Methods for studying inorganic substances and materials. Classification and nomenclature of inorganic compounds. Liquid-phase synthesis of inorganic substances. Solid-phase synthesis of inorganic substances. Physicochemical bases of substances purification. Distillation and extraction methods of purification. Methods for controlling the degree of purity of chemical compounds

*Learning Outcomes:*

*Learning Outcomes in EP (LOP)*

LOP5 - Possesses communication technologies, scientific rhetoric skills, and communication strategies.  
LOP6 - Has an understanding of the system of fundamental chemical concepts and methodological aspects of chemistry, their role in the General professional training of chemists.

*Learning Outcomes in Course (LOC)*

LOD 1 – Mastering the types of reactions used in the study of inorganic substances.  
LOD2 - Mastering methods of physical and chemical research of inorganic compounds.  
LOD3-Can distinguish between the main types of inorganic materials used in production.  
LOD4 - Organizes reaction methods in inorganic synthesis.  
LOD5-Knows the features of these reactions in the production of inorganic material.  
ROD 6 - Works on inorganic synthesis.  
LOD 7- In practice, uses methods of physical and chemical analysis of inorganic compounds

*Post requisites: no*

*Component of choice 4*

**Course: Computer materials science**

*Intensity of the Course:* 5 academic credits

**Module Code: MDCh-3**

*Module Name:* Fundamentals of Research Methodology

*Prerequisites:* OKCh 3306.1 Fundamentals of Computational Chemistry

*Purpose:* To acquaint undergraduates with scientific, technical, pedagogical information systems, to teach methods of independent search for the necessary information using new information technologies

*Short Description:* The era of computer materials science. Mathematical methods for modeling, pattern recognition and data security. Predicting the properties of matter based on quantum mechanical laws. Formation of micro and nanoparticles from steam. Material design. Ionic conductor for lithium cells. Thermoelectric converter.

*Learning Outcomes:*

*Learning Outcomes in EP (LOP)*

LOP5 - Possesses communication technologies, scientific rhetoric skills, and communication strategies.  
LOP7 - Has research and digital skills.

*Learning Outcomes in Course (LOC)*

LOD 1 – Possesses knowledge in the field of pedagogical innovations, pedagogical technologies.  
LOD 2-Knows how to competently perform scientific and practical work.  
LOD 3 - Knows how to conduct research.  
LOD 4 - Can work with reference books.  
LOD 5 - Ability to distinguish between types of reference literature, independently compose definitions of concepts. LOD 6 - Receives professional work based on scientific evidence.  
LOD 7- Has the ability to innovate.

*Post requisites:* DIE 6305.2 Digital information in education

*Component of choice 5*



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**Course: Theoretical and Applied Electrochemistry**

*Intensity of the Course:* 6 academic credits

*Module Code:* **MDCh-3**

*Module Name:* Fundamentals of Research Methodology

*Prerequisites:* EH 3313 Electrochemistry

*Purpose:* Is the study of the basic laws governing the chemical process, and the implementation of the following tasks: a) calculate the kinetics of the electrochemical process, determine the mechanism of the process (electrochemical conditions and product yield); b) a decrease in the electrochemical characteristics of the process, speed, electrical conductivity, energy calculation, making the necessary conclusions; c) knowledge of the basic laws and equations of electrochemistry.

*Short Description:* The subject and tasks of theoretical and applied electrochemistry. Electrochemical cells. Auxiliary electrodes. Reference electrodes. Rotating disc electrode. Measurement methods in electrochemistry. Conductometry. Potentiometry. Coulometry. Chemical power sources. Fuel cells. Kinetics of anodic oxidation. Cathodic processes. Environmental problems of electroplating industries and methods for their solution

*Learning Outcomes:*

*Learning Outcomes in EP (LOP)*

LOP6 - Has an understanding of the system of fundamental chemical concepts and methodological aspects of chemistry, their role in the General professional training of chemists.

LOP8 - Conducts original research that expands the scope of existing knowledge.

*Learning Outcomes in Course (LOC)*

LOD1 - The concept of modern theoretical aspects of chemical science is expanding.

LOD 2 - Learns methods for conducting experiments in chemistry.

LOD3 - Knows the main classes of chemical compounds, the basics of methods for their synthesis.

LOD 4 - Study of the electronic and spatial structure of chemical compounds.

LOD5 - Knows the concepts of basic types and mechanisms of chemical reactions.

LOD 6 - Can apply theoretical foundations and practices based on chemical and instrumental methods of analysis.

LOD7-Can conduct experiments independently

*Post requisites:* TPFH5301 Theory and problems of physical chemistry

*Component of choice 5*

**Course: Modern petrochemical technologies**

*Intensity of the Course:* 6 academic credits

*Module Code:* **MDCh-3**

*Module Name:* Fundamentals of Research Methodology

*Prerequisites:* Organic and petrochemical production technology.

*Purpose:* To form systematic knowledge on reducing the technical load on the environment during the processing of hydrocarbons into environmentally friendly fuels.

*Short Description:* Processes of petrochemical industries occurring during the processing of high-viscosity oils and natural bitumen, mathematical models for describing the processes. Application of modern software products to describe the processes of petrochemical production. Analogy of processes of



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mass, heat and impulse transfer. The problem of large-scale transition for industrial vehicles. The use of modern software products for describing the processes of petrochemical production

*Learning Outcomes:*

*Learning Outcomes in EP (LOP)*

LOP4 - Capable of complex analysis and forming judgments about global environmental and economic problems and rational use of natural resources.

LOP8 - Conducts original research that expands the scope of existing knowledge.

*Learning Outcomes in Course (LOC)*

LOD 1 - He mastered the basic principles of the technology of organic and petrochemical synthesis of important industrial products.

LOD 2 - Can be used in the analysis of the main indicators of oil and oil products.

LOD 3 - Can use physical and chemical measurements of fixed assets and devices.

LOD 4 - Can be used with physicochemical definitions. LOD 5 - Reference materials on analytical methods of design, construction, calculation of technological equipment for oil and oil products for chemical industry enterprises.

LOD 6 - Learning to look for information.

LOD 7- Gains new knowledge in the field of modern achievements in the technology of petrochemical production.

*Post requisites: no*

*Component of choice 6*

**Course: Synthesis and identification of organic compounds**

*Intensity of the Course:* 6 academic credits

*Module Code:* FRM-4

*Module Name:* Fundamentals of Research Methodology

*Prerequisites:* SMFHIOS 5206 Modern methods of physical and chemical research of organic compounds.

*Purpose:* To consolidate the knowledge of chemistry undergraduates in the field of organic chemistry

*Short Description:* Classification of methods for the isolation and purification of organic compounds. Filtration, centrifugation, recrystallization, sublimation, extraction, drying. Distillation. Chromatography. Determination of the basic physical constants of organic substances. Physicochemical methods for the study of organic compounds. Electronic spectroscopy (UV and visible region). Infrared spectroscopy. Nuclear magnetic resonance spectroscopy.

*Learning Outcomes:*

*Learning Outcomes in EP (LOP)*

LOP 7 - Has the skills to use modern instrumentation in the field of fine organic synthesis, elemental and spectral analysis, gas chromatography-mass spectrometry. for solving specific research and applied problems;

LOP 9 – Prepared for independent research activities, requiring broad fundamental training in modern areas of chemistry, deep specialized training in the chosen direction, possession of the skills of modern experimental methods



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LOP 11 – Possesses communication skills, including the skills of organizing teamwork, organizing the interaction of specialists in related specialties, the skills of public discussion of professional projects and results, including the use of English

*Learning Outcomes in Course (LOC)*

LOD 1 - Knows the types of reactions used in organic synthesis, the features of these reactions in the production of organic material.

LOD 2 - Knows the methods of physical and chemical analysis of organic compounds, the main types of organic materials used in production.

LOD 3 - Uses methods of physical and chemical analysis of organic compounds.

LOD 4 - Knows how to use scientific literature in the synthesis of organic compounds by selected methods.

LOD 5 - Can organize the methods of reactions that take place in organic synthesis.

LOD 6 - Knows the methods of physical and chemical analysis of organic compounds.

LOD 7 - Works on organic synthesis.

*Post requisites:* MPOCh 6307 Modern Problems of Organic Chemistry.

*Component of choice 6*

*Course:* **Modern problems of organic chemistry**

*Intensity of the Course:* 5 academic credits

*Module Code:* **BSR-4**

*Module Name:* Fundamentals of Scientific Research

*Prerequisites:* SMFHIOС 5206 Modern methods of physical and chemical research of organic compounds.

*Purpose:* To consolidate the knowledge of undergraduates with basic knowledge in organic chemistry. Knowledge of the basic theoretical problems of organic chemistry, hydrocarbons, nomenclature, isomerism, basic classes.

*Short Description:* The theory of electron displacements in organic compounds. Classification of organic reactions. Radical reactions. Nucleophilic substitution at a saturated carbon atom. Nucleophilic substitution at an aliphatic trigonal carbon atom. Substitution reactions in the aromatic series. Diazo and azo compounds. Amination reactions. Oxidation and reduction reactions. Mechanism of redox reactions. Polymers. Polymerization and polycondensation reactions.

*Learning Outcomes:*

*Learning Outcomes in EP (LOP)*

LOP5 - Possesses communication technologies, scientific rhetoric skills, and communication strategies.

LOP6 - Has an understanding of the system of fundamental chemical concepts and methodological aspects of chemistry, their role in the General professional training of chemists.

*Learning Outcomes in Course (LOC)*

LOD 1 - Knows the types of isomerism of organic substances, methods of obtaining representatives of the most important classes of organic compounds.

LOD 2 - owns chemical and physical methods for identifying organic compounds.

LOD 3 - Creation of names for organic compounds according to the rules of the IUPAC nomenclature, forms the structural formulas of substances by their names.

LOD 4 - Can determine the nature of the distribution of electron density in molecules taking into account the effects of electronic effects.

LOD 5 - Has mastered the construction of the structure of substances based on their chemical properties and spectral characteristics.



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LOD 6 - Separation and purification of organic substances, allows you to determine their purity.

LOD 7- Can predict preparation methods and chemical properties of compounds based on their structure.

*Post requisites:* SIOC 6303 Synthesis and identification of organic compounds