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**Federal State Autonomous Educational Institution of Higher Education
PEOPLES' FRIENDSHIP UNIVERSITY OF RUSSIA
RUDN University**

Faculty of Science

educational division (faculty/institute/academy) as higher education programme developer

COURSE SYLLABUS

Actual problems of modern chemistry

course title

Recommended by the Didactic Council for the Education Field of:

04.04.01 «Chemistry»

field of studies / speciality code and title

The course instruction is implemented within the professional education programme of higher education:

«Bioenergies and Biorefineries»

higher education programme profile/specialisation title

2025

1. COURSE GOAL

The goal of the course “Actual problems of modern chemistry” is to familiarize with the basic concepts of modern directions of chemistry development, both fundamental and practical significance. To introduce students to modern concepts of developing new synthetic approaches, equipment used in organic chemistry. To define the limits of applicability and the problems of existing methods.

2. REQUIREMENTS FOR LEARNING OUTCOMES

Mastering the course “Actual problems of modern chemistry” is aimed at the development of the following competences:

Table 2.1. List of competences that students acquire through the course study

Competence code	Competence descriptor	Competence formation indicators (within this course)
GC-1	Ability to carry out critical analysis of problem tasks applying a systematic approach, to develop an action strategy.	GC-1.1 Ability to analyze the problem task as a system, identifying its components and relationships between them;
		GC-1.2 Ability to identify lack in information needed to solve a problem task and to design processes to address them;
		GC-1.3 Ability to critically evaluate the reliability of information sources, to work with conflicting information from different sources;
		GC-1.4 Ability to develop and substantively argue a strategy for solving a problem situation based on a systematic and interdisciplinary approach;
		GC-1.5 Ability to use logical and methodological tools for a critical assessment of modern concepts of a philosophical and social nature in its subject area
GC-6	Ability to identify and implement the priorities of their own activities and self-development based on self-assessment.	GC-6.1 Ability to evaluate their resources and their limits (personal, situational, temporary), optimally use them for the successful completion of the assigned task
		GC-6.2 Ability to determine the priorities of professional growth and ways to improve their own activities based on self-assessment according to the selected criteria
		GC-6.3 Ability to build a flexible professional trajectory using the tools of continuing education, taking into account the accumulated experience of professional activity and dynamically changing requirements of the labour market
GPC-1	The ability to carry out complex experimental and computational-theoretical studies in the chosen field of chemistry or related sciences using modern equipment,	GPC-1.1 Ability to use existing and to develop new methods for obtaining and characterizing substances and materials for solving problems in the chosen field of chemistry or related sciences.
		GPC-1.2 Ability to use modern equipment, software and professional databases for solving

Competence code	Competence descriptor	Competence formation indicators (within this course)
	software and databases for professional purposes.	problems in the chosen field of chemistry or related sciences GPC-1.3 Ability to use modern computational and theoretical methods of chemistry to solve professional problems
GPC-2	The ability to analyze, interpret and generalize the results of experimental and computational-theoretical work in the chosen field of chemistry or related sciences.	GPC-2.1 Ability to carry out a critical analysis of the results of own experimental and computational-theoretical works and to interpret them correctly GPC-2.2 Ability to formulate summary and conclusions based on the results of the analysis of literature data, own experimental and computational-theoretical works in the chosen field of chemistry or related sciences
GPC-4	Ability to prepare publications, participate in professional discussions, present the results of professional activities in the form of scientific and popular science reports	GPC-4.1 Ability to present the results of the research in the form of scientific publications (abstract, paper, review) in Russian and in English GPC-4.2 Ability to present the results of the research orally in Russian and English

3. COURSE IN HIGHER EDUCATION PROGRAMME STRUCTURE

The course “Actual problems of modern chemistry” refers to the **core** component of B1 block of the higher educational programme curriculum.

Within the higher education programme students also master other (modules) and / or internships that contribute to the achievement of the expected learning outcomes as results of the course study.

Table 3.1. The list of the higher education programme components/disciplines that contribute to the achievement of the expected learning outcomes as the course study results

Competence code	Competence descriptor	Previous courses/modules*	Subsequent courses/modules*
GC-1	Ability to carry out critical analysis of problem tasks applying a systematic approach, to develop an action strategy.		Student Scientific-Research work Pre-graduation practical training
GC-6	Ability to identify and implement the priorities of their own activities and self-development based on self-assessment.		Student Scientific-Research work Pre-graduation practical training

Competence code	Competence descriptor	Previous courses/modules*	Subsequent courses/modules*
GPC-1	The ability to carry out complex experimental and computational-theoretical studies in the chosen field of chemistry or related sciences using modern equipment, Student Scientific-Research work Pre-graduation practical training software and databases for professional purposes.		Student Scientific-Research work Pre-graduation practical training
GPC-2	The ability to analyze, interpret and generalize the results of experimental and computational-theoretical work in the chosen field of chemistry or related sciences.		Student Scientific-Research work Pre-graduation practical training
GPC-4	Ability to prepare publications, participate in professional discussions, present the results of professional activities in the form of scientific and popular science reports		Student Scientific-Research work Pre-graduation practical training

* To be filled in according to the competence matrix of the higher education programme.

4. COURSE WORKLOAD AND ACADEMIC ACTIVITIES

1)The total workload of the course “Actual problems of modern chemistry” is 11 credits (396 academic hours).

*Table 4.1. Types of academic activities during the periods of higher education programme mastering (**full-time training**)**

Type of academic activities		Total academic hours	Semesters/training modules			
			1	2	3	4
<i>Contact academic hours</i>		152	36	48	36	32
including:						
Lectures (LC)		84	18	32	18	16
Lab work (LW)		68	18	16	18	16
Seminars (workshops/tutorials) (S)						
<i>Self-studies</i>		190	27	42	63	58
<i>Evaluation and assessment (exam/passing/failing grade)</i>		54	9	18	9	18
Course workload	academic hours	396	72	108	108	108
	credits	11	2	3	3	3

5. COURSE MODULES AND CONTENTS

Table 5.1. Course contents and academic activities types

Course module title	Course module contents (topics)	Academic activities types
Module 1. Introduction.	Topic 1.1 The genesis of problematics in organic chemistry. Various search strategies for biologically active organic compounds: targeted synthesis and creation of molecular diversity.	LC
Module 2. Modern methods of isolation of organic compounds	Topic 2.1 Classical methods of isolation of organic compounds (filtration, distillation, recrystallization, extraction, chromatography).	LC, LW
	Topic 2.2 Solid-phase synthesis. The use of ionic liquids. Perfluorinated systems.	LC, LW
Module 3. Modern approaches to conducting chemical reactions.	Topic 3.1 Solid-phase synthesis. The use of ionic liquids. Perfluorinated systems. The use of microwave irradiation and ultrasound. Flow synthesis. Reagents based on hypervalent iodine.	LC, LW
Module 4. The use of protective groups in organic synthesis.	Topic 4.1 Basic principles for the introduction and removal of protective groups. Hydroxyl protection. Amino group protection. Protection of the carboxyl group.	LC, LW
Module 5. Modern approaches to the creation of new synthetic methods	Topic 5.1 Basic principles of green chemistry, atom-economy, industrial chemistry.	LC, LW
Module 6. Introduction to metal complex catalysis	Topic 6.1 Fundamentals of complex formation. Catalytic hydrogenation methods. Catalytic methods of oxidation. Cross-coupling reactions. Metal-catalyzed reactions of creating C-C and C-heteroatom bonds. C-H Activation.	LC, LW
Module 7. Introduction to organocatalysis.	Topic 7.1 Basic principles of organocatalysis. Reactions catalyzed by Lewis organic bases; Lewis acids; Brönsted bases; Brönsted acids.	LC, LW
Module 8. Cycloaddition reactions in organic	Topic 8.1 The most important classes of cycloaddition in organic chemistry. [2+4]	LC, LW

Course module title	Course module contents (topics)	Academic activities types
synthesis.	Cycloaddition. [2+3] Cycloaddition. Basic principles of click chemistry.	

* - to be filled in only for **full**-time training: *LC* - lectures; *LW* - lab work; *S* - seminars.

6. CLASSROOM EQUIPMENT AND TECHNOLOGY SUPPORT REQUIREMENTS

Table 6.1. Classroom equipment and technology support requirements

Type of academic activities	Classroom equipment	Specialised educational / laboratory equipment, software, and materials for course study (if necessary)
Lecture	A lecture hall for lecture-type classes, equipped with a set of specialised furniture; board (screen) and a set of devices for multimedia presentations.	Projector, motorized screen for projectors, wi-fi
Lab work	A classroom for laboratory work, individual consultations, current and mid-term assessment; equipped with a set of specialised furniture and machinery.	A set of specialized furniture; specialized equipment of the chemical laboratory: fume hood SHVP-4, fume hood SHVP-2, rotary evaporator Hei-value digital G3B, rotary evaporator IKA, digital devices for determining the melting point SMP10; electronic laboratory scales AND EK-610, MK-M flask heaters of different volumes, drying cabinet, magnetic stirrer MRHei-Mix S, magnetic stirrer with heating MRHei-Standart, refractometer, combined laboratory water bath, vacuum chemical station RS3001 VARIO-pro, circulation cooler Rotacool Mini, rotary plate pump vacuum RZ2.5, membrane vacuum chemical pump MZ2CNT, Steinel thermal air blower, Spectroline UV lamp, electronic vacuum controller with CVC3000 detect Vacuumbrand valve, stainless steel emergency cabin SHVV, chemical

Type of academic activities	Classroom equipment	Specialised educational / laboratory equipment, software, and materials for course study (if necessary)
		dishes, refrigerator; wi-fi
Self-studies	A classroom for self-studies (can be used for seminars and consultations), equipped with a set of specialised furniture and computers with access to the electronic information and educational environment.	Faculty of Science Reading Room Ordzhonikidze D.3. Coworking area Monday - Friday 10.00 – 22.00 Reading room of the main building of the RUDN Coworking area Monday - Saturday 9.00 - 23.00 Hall No. 2 Monday - Thursday 10.00 - 17.45 Friday 10.00 - 16.45 Hall No. 6 Monday - Thursday 10.00 - 17.45 Friday 10.00 - 16.45

* The premises for students' self-studies are subject to **MANDATORY** mention

7. RECOMMENDED RESOURCES FOR COURSE STUDY

Main sources:

1. Mathews, J. C. (1971). Problems in modern chemistry.
2. Smith, M. B. (2020). March's advanced organic chemistry: reactions, mechanisms, and structure. John Wiley & Sons.
3. Jha, A. K. (2023). Solid-State Chemistry: A Modern Approach. CRC Press.
4. Uskoković, V. (2010). Major Challenges for Modern Chemistry in Particular and Science in General. Foundations of Science, 15(4), 303–344. doi:10.1007/s10699-010-9185-8

Additional sources:

1. Website of the American Chemical Society ACS Publications: Chemistry journals, books, and references <https://pubs.acs.org/>
2. <http://www.thieme.com/journals-main>
3. <http://onlinelibrary.wiley.com/>
4. <http://www.springer.com/gp/products/journals>
5. Server with the ability to search for methods for synthesizing compounds <http://www.orgsyn.org/>

Internet sources

1. Electronic libraries with access for RUDN students:

- RUDN Electronic Library System (RUDN ELS) <http://lib.rudn.ru/MegaPro/Web>
- EL "University Library Online" <http://www.biblioclub.ru>
- EL "Yurayt" <http://www.biblio-online.ru>
- EL "Student Consultant" www.studentlibrary.ru
- EL "Lan" <http://e.lanbook.com/>
- EL "Trinity Bridge"

Databases and search engines:

- electronic foundation of legal and normative-technical documentation <http://docs.cntd.ru/>
- Yandex search engine [https:// www .yandex.ru/](https://www.yandex.ru/)
- Google search engine <https://www.google.ru/>
- Scopus abstract database <http://www.elsevierscience.ru/products/scopus/>
- www.scholar.google.ru

*Training toolkit for self- studies to master the course *:*

1. A set of lectures on "Actual problems of modern chemistry"
2. The laboratory workshop on "Actual problems of modern chemistry"

* The training toolkit for self- studies to master the course is placed on the course page in the university telecommunication training and information system under the set procedure.

DEVELOPERS:

Head of Organic Chemistry

Voskressensky L.G.

Department

position, department	signature	name and surname
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Senior Lecturer of Organic

Festa A.A.

Chemistry Department

position, department	signature	name and surname
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**HEAD OF EDUCATIONAL
DEPARTMENT:**

Organic Chemistry Department

Voskressensky L.G

name of department	signature	name and surname
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**HEAD
OF HIGHER EDUCATION
PROGRAMME:**

Dean of Faculty of Science,

Head of Organic Chemistry

Voskressensky L.G

Department

position, department	signature	name and surname
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