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

Bioenergy

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 “Bioenergy” is to familiarize with the basic concepts of bioenergy. To introduce students to the biofuels type and importance. To define the applicability limits and the existing methods problems.

2. REQUIREMENTS FOR LEARNING OUTCOMES

Mastering the course “Bioenergy” 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-2	Ability to manage a project at all stages of its life cycle.	GC-2.1 Ability to formulate, on the basis of the posed problem, a project task and a way to solve it through the implementation of project management;
		GC-2.2 Ability to develop the project concept within the framework of the indicated problem: to formulate the goal, objectives, to justify the relevance, significance, expected results and possible areas of their application;
		GC-2.3 Ability to plan the necessary resources, including taking into account their replaceability;
		GC-2.4 Ability to develop a project implementation plan using planning tools;
		GC-2.5 Ability to monitor the progress of the project, to correct deviations, to make additional changes to the project implementation plan, to clarify the areas of responsibility of the project participants
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, software and databases for professional purposes.	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 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

Competence code	Competence descriptor	Competence formation indicators (within this course)
GPC-3	Ability to use computational methods and adapt existing software products to solve problems of professional activity.	GPC-3.1 Ability to use modern IT-technologies in the collection, analysis, and presentation of chemical profile information;

3. COURSE IN HIGHER EDUCATION PROGRAMME STRUCTURE

The course "Bioenergy" refers to the **variable** 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-2	Ability to manage a project at all stages of its life cycle.		Student Scientific- Research work Pre-graduation practical training
GPC-1	Ability to carry out complex experimental and computational-theoretical studies in the chosen field of chemistry or related sciences using modern equipment, software and databases for professional purposes.		Actual problems of modern chemistry Advanced Organic Synthesis Catalyst (nanomaterials) design and applications Catalysis: from Basic principles to applications. Homogeneous, Heterogeneous, Photocatalysis, Biocatalysis, Electrocatalysis Experimental lab 1: Flow synthesis and alternative technologies Experimental lab 2: Biorefineries and Bioproducts Experimental lab 3: Advanced Organic Synthesis Student Scientific-Research work Pre-graduation practical training
GPC-2	Ability to analyze, interpret and generalize the results of experimental and		Actual problems of modern chemistry Bioproducts, Biomaterials and Biorefineries

Competence code	Competence descriptor	Previous courses/modules*	Subsequent courses/modules*
	computational-theoretical work in the chosen field of chemistry or related sciences.		Advanced Organic Synthesis Catalyst (nanomaterials) design and applications Catalysis: from Basic principles to applications. Homogeneous, Heterogeneous, Photocatalysis, Biocatalysis, Electrocatalysis Experimental lab 1: Flow synthesis and alternative technologies Experimental lab 2: Biorefineries and Bioproducts Experimental lab 3: Advanced Organic Synthesis Student Scientific-Research work Pre-graduation practical training
GPC-3	Ability to use computational methods and adapt existing software products to solve problems of professional activity		Bioproducts, Biomaterials and Biorefineries Catalyst (nanomaterials) design and applications Experimental lab 3: Advanced Organic Synthesis Artificial intelligence and additive technologies in chemistry 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 "Bioenergy" is 4 credits (144 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
Contact academic hours	*27*	*27*			
including:					
Lectures (LC)	18	18			
Lab work (LW)	9	9			
Seminars (workshops/tutorials) (S)					
Self-studies	*108*	*108*			
Evaluation and assessment (exam/passing/failing grade)	*9*	*9*			

Type of academic activities		Total academic	Semesters/training modules			
			1	2	3	4
Course workload	academic hours	**144**	**144**			
	credits	**4**	**4**			

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. Biofuels	Topic 1.1 An introduction, current status, merits and demerits, characterization techniques of biomass, comparisons between fossil fuels and biofuels. Energy demands (quiz), energy facts and prospects for the future.	LC
Module 2. Types of biofuels and classification. Liquid biofuels (first generation)	Topic 2.1 Biodiesel. Preparation and types (first vs second generation). Processes. Prospects and perspectives. The food vs fuel and related issues.	LC, LW
	Topic 2.2 Bioethanol. Preparation and types (first vs second generation). The food vs fuel issue and the blend wall. Prospects and perspectives.	LC, LW
Module 3. Liquid biofuels (Second generation): constraints, impacts and benefits of lignocellulose conversion pathways	Topic 3.1 Biodiesel vs green diesel. Processes and technologies. Prospects and perspectives.	LC, LW
	Topic 3.2 Bioethanol: lignocellulosic biomass, syngas fermentation to bioethanol. Preparation and processes. Prospects and perspectives.	
	Topic 3.3 Other biofuels (synthetic fuels). BTL. Pyrolysis oils. Sunfuel. Other synthetic fuels. Preparation and processes. Prospects and perspectives.	
Module 4. Gaseous biofuels.	Topic 4.1 Biogas: a promising clean energy technology. Preparation and processes. Purification. Examples. Prospects and perspectives.	LC, LW
	Topic 4.2 Hydrogen: technologies for renewable hydrogen production, hydrogen production from electrolysis, technico-economic evaluation of hydrogen energy by flow sheeting simulation and economic evaluation, assessment of combined renewable sources and hydrogen storage for residential applications	
Module 5. Solid Fuels	Topic 5.1 Solid Fuels. Pellets. Preparation and processes. Heat and power applications. Prospects and perspectives.	LC, LW
Module 6. Life cycle assessment of biofuels	Topic 6.1 Life cycle assessment of biofuels. Systems analysis and possibilities. Prospects and perspectives.	LC, LW
Module 7. Conclusions and prospects.	Topic 7.1 Conclusions and prospects: economic, social and ecological impacts of bioenergy at	LC

Course module title	Course module contents (topics)	Academic activities types
	local, national and global levels. Implications and current issues and future perspectives.	

* - 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, emergency cabin made of stainless steel SHVV,

Type of academic activities	Classroom equipment	Specialised educational / laboratory equipment, software, and materials for course study (if necessary)
		chemical 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. Bioenergy Engineering: fundamentals, methods, modelling and application, Ed K. Shadangi, P. Sarangi, K. Mohanty, I. Deniz, A. Gollakota, 2023
2. Liquid biofuels: fundamentals, characterization and applications, Ed K.P. Shadangi, 2021
3. Lignocellulosic biomass to liquid biofuels, Ed A. Yousuf, D. Pirozzi, F. Sannino, 2021

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"

2. Databases and search engines:

- electronic foundation of legal and normative-technical documentation http://docs.cntd.ru/
- Yandex search engine 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 “Bioenergy”
2. The laboratory workshop on “Bioenergy”

* 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:

Organic Chemistry Department		**Rafael Luque**
position, department	signature	name and surname
Organic Chemistry Department		**Christophe Len**
position, department	signature	name and surname

HEAD OF EDUCATIONAL DEPARTMENT:

Organic Chemistry Department		**Voskressensky L.G.**
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HEAD OF HIGHER EDUCATION PROGRAMME:

Dean of Faculty of Science,		
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