UNIWERSYTET IM. ADAMA MICKIEWICZA W POZNANIU

Basic Organic Chemistry 1

Educational subject description sheet

Basic information

Study programme Chemia (General Chemistry) **Speciality** - **Organizational unit** Faculty of Chemistry **Study level** First-cycle programme **Study form** Full-time **Education profile** General academic	**Didactic cycle** 2023/24 **Subject code** 02CENS.14K.01820.23 **Lecture languages** English **Course type** Obligatory **Block** Major subjects

Subject coordinator	Jakub Grajewski, Justyna Walkowiak-Kulikowska
Lecturer	Jakub Grajewski, Tomasz Cytlak

Period	**Activities and hours**	**Number of ECTS points**
Semester 3	• Lecture: 45, Exam • Classes: 30, Graded credit • Laboratories: 120, Graded credit	12

Goals

Code	Goal
C1	Transfer of knowledge of the structure of organic compounds, the influence of the electronic structure on the properties of a compound and the course of organic reactions, methods of identification of compounds and determination of their structures, isomerism phenomena, systematic nomenclature of organic compounds and the rules of health and safety and handling organic compounds - development of the ability to predict the course of reactions based on the knowledge of the properties and structures of compounds, gaining the ability to create reaction mechanisms, developing the skill of predicting the influence of the reaction environment on the properties and reactivity of organic compounds.
C2	Developing the ability to use research methods to determine the structure of organic compounds.
C3	Preparation for planning the transformation of organic compounds, the creation of functional groups and the transformation of one functional group into another.
C4	Developing the ability to plan organic synthesis, including multi-stage synthesis, and to evaluate alternative synthetic pathways.
C5	Developing communication and teamwork skills.
C6	Getting acquainted with the basic rules of health and safety in the laboratory.
C7	Understanding the course of a chemical reaction by understanding the mechanism.
C8	Developing the ability to write scientific work and use literature sources (textbooks and tables), preparation of documentation, journal and laboratory work reports.

Entry requirements

Positive grade from the "Introduction to organic chemistry" course.

Subject learning outcomes

Code	Outcomes in terms of	Learning outcomes	Examination methods
Knowledge – Student:			
W1	knows the rules for naming organic compounds.	CEN_K1_W01, CEN_K1_W04	Written exam, Written colloquium, Oral colloquium, Test, Report, Practical exam
W2	understand the consequences of carbon atom hybridization and their impact on the type of bonds formed.	CEN_K1_W05, CEN_K1_W06, CEN_K1_W08, CEN_K1_W10, CEN_K1_W12	Written exam, Written colloquium, Oral colloquium, Test, Report, Practical exam
Skills – Student:			
U1	explains the properties of compounds depending on their structure, formulate systematic names correctly, demonstrate knowledge of common names of compounds.	CEN_K1_U01, CEN_K1_U02, CEN_K1_U03	Written exam, Written colloquium, Oral colloquium, Test, Report
U2	distinguishs between electrophilic and nucleophilic, molecules.	CEN_K1_U03	Written exam, Written colloquium, Oral colloquium, Test
U3	understands and create reaction mechanisms, illustrate the movement of electrons properly and the formation and breaking of bonds.	CEN_K1_U02, CEN_K1_U03, CEN_K1_U05	Written exam, Written colloquium, Oral colloquium, Test, Report

Code	Outcomes in terms of	Learning outcomes	Examination methods
U4	plans to synthesize an organic compound, also in several stages.	CEN_K1_U02, CEN_K1_U03, CEN_K1_U04, CEN_K1_U05	Written exam, Written colloquium, Oral colloquium, Test
U5	proposes the result of a chemical reaction depending on the reagents used and the reaction conditions.	CEN_K1_U02, CEN_K1_U03, CEN_K1_U04, CEN_K1_U05	Written exam, Written colloquium, Oral colloquium, Test, Report
U6	recognizes and name constitutional isomers and stereoisomers.	CEN_K1_U01, CEN_K1_U02, CEN_K1_U03	Written exam, Written colloquium, Test
U7	interprets the results of spectral analyses of organic compounds, propose an appropriate method to study various aspects of the structure.	CEN_K1_U03, CEN_K1_U16, CEN_K1_U17, CEN_K1_U19	Written exam, Written colloquium, Test, Report
U8	uses literature sources, textbooks and tables in English.	CEN_K1_U22, CEN_K1_U23, CEN_K1_U24, CEN_K1_U25	Written exam, Written colloquium, Oral colloquium, Test, Report
U9	interprets the results of the conducted experiments correctly.	CEN_K1_U05, CEN_K1_U25, CEN_K1_U26	Written colloquium, Oral colloquium, Test, Report, Practical exam
U10	writes a laboratory report / journal on the experiment performed.	CEN_K1_U22, CEN_K1_U24, CEN_K1_U25, CEN_K1_U27	Test, Report, Practical exam
Social competences – Student:			
K1	evaluates objectively the contribution of one's own work and that of others in the joint research and report preparation.	CEN_K1_K05	Oral colloquium, Practical exam
K2	applies the health and safety rules in a lab.	CEN_K1_K03, CEN_K1_K04, CEN_K1_K05	Written colloquium, Oral colloquium, Report, Practical exam

Study content

No.	Course content	Subject learning outcomes	Activities
1.	Introduction to organic chemistry, carbon atom hybridization, chemical bonds, their types, atomic and molecular orbitals.	W1, W2, U1, U2	Lecture, Classes, Laboratories
2.	Polarity of molecules, influence of structure on properties, intermolecular interactions.	W2, U1, U2, U3	Lecture, Classes, Laboratories
3.	Acids and bases in organic chemistry, basic theories of acidity (Bronsted, Lewis), protic and aprotic solvents.	W2, U1, U3	Lecture, Classes, Laboratories
4.	Aliphatic hydrocarbons, structure and properties, isomerism, radical substitution reactions, radical stability and structure.	W2, U1, U3, U5	Lecture, Classes, Laboratories

No.	Course content	Subject learning outcomes	Activities
5.	Stereochemistry I, the concept of configuration and conformation, alkanes conformations, Newman projections, cycloalkanes and their stereochemistry, elasticity theory, cyclohexane conformations.	W1, W2, U1, U3, U6	Lecture, Classes
6.	Unsaturated hydrocarbons: alkenes and alkynes, methods of preparation and reactivity, addition reactions and the rules governing them, acidity of terminal alkynes.	W1, W2, U1, U2, U3, U5	Lecture, Classes, Laboratories
7.	Conjugated dienes, stabilization effect by coupling, addition 1,2 and 1,4, kinetic and thermodynamic control, Diels-Alder reaction.	W1, W2, U1, U2, U3, U5, U6	Lecture, Classes, Laboratories
8.	Aromatic compounds, the concept and criteria of aromaticity, resonance stabilization, polycyclic aromatic compounds; benzene reactions, aromatic electrophilic substitution, substituent effect, synthesis of benzene derivatives, aromatic nucleophilic substitution.	W1, W2, U1, U2, U3, U4, U5	Lecture, Classes, Laboratories
9.	Stereochemistry II, enantiomers, chirality, graphical representation of stereoisomerism, Fischer projection, enantiomers, diastereoisomers, meso compounds, configuration determination (relative and absolute).	W1, W2, U1, U2, U6	Lecture, Classes, Laboratories
10.	Alkyl halides, substitution reactions, nucleophilic substitution, substitution stereochemistry, concepts: nucleophile, nucleophilicity and basicity. Substitution stereochemistry, SN1 and SN2 mechanisms, dependence on the structure and reaction conditions, elimination reactions, rules applicable in these reactions, E1 and E2 mechanisms, elimination stereochemistry, competition of elimination and substitution, factors influencing the dominant direction of the reaction.	W1, U1, U2, U3, U4, U6	Lecture, Classes, Laboratories
11.	Grignard reactions, application of organometallic compounds in organic synthesis.	W2, U1, U3, U4	Lecture, Classes, Laboratories
12.	Alcohols – synthesis reaction, properties, reactivity, acidity of the OH group, reactions of alcohols, types of leaving groups, oxidation of alcohols, transformation into ethers.	W2, U1, U3, U4, U5	Lecture, Classes, Laboratories
13.	Properties and structure of ethers, cyclic ethers, epoxides, ethers complexing properties, crown ethers.	W2, U1, U3, U4, U5	Lecture, Classes, Laboratories
14.	Carbonyl compounds, oxidation reactions, hybridization of carbonyl group atoms and bond polarization, addition reactions (hemiacetals, acetals, oximes, imines, enamines, cyanohydrins, addition of organometallic compounds).	W2, U2, U4, U5	Lecture, Classes, Laboratories
15.	Carboxylic acids and their derivatives, acidity of the carboxyl group, different reactivity of derivatives in the substitution reaction at the carbonyl group, reactions for the synthesis and conversion of acid derivatives.	W2, U1, U4, U5	Lecture, Classes, Laboratories
16.	Acidity of hydrogen atoms in the alpha position to the carbonyl group, application in synthesis (malonate, acetoacetate, acetylacetone), enolization of carbonyl compounds and reactivity of enols.	U3, U4, U5	Lecture, Classes, Laboratories

No.	Course content	Subject learning outcomes	Activities
17.	Amines- structure and basicity, synthesis reactions, inversion on the nitrogen atom. Hoffman's elimination.	W2, U1, U3, U4	Lecture, Classes, Laboratories
18.	Organic synthesis - examples of synthesis preparation.	W2, U4, U7, U8, U9, K2	Lecture, Classes, Laboratories
19.	Spectroscopic methods for studying the structure of organic compounds (IR, NMR, MS, UV-VIS), examples of spectrum interpretation.	U10, U7, U8, U9	Lecture, Classes, Laboratories
20.	Basic classes of organic reactions: addition, elimination, substitution, condensation, rearrangement, pericyclic reactions.	W1, W2, U1, U2, U3, U8	Lecture, Classes, Laboratories
21.	Basic canons of organic synthesis.	W1, U10, U7, U8, U9, K1, K2	Lecture, Classes, Laboratories

Additional information

Activities	Teaching and learning methods and activities
Lecture	Lecture with a multimedia presentation of selected issues, Problem-based lecture
Classes	Discussion, Case study, Classes method, Research method (scientific inquiry)
Laboratories	Discussion, Laboratory method, Demonstration and observation, Work in groups

Activities	Credit conditions
Lecture	The passing condition for the module is obtaining a positive grade in the seminar and laboratory, as well as scoring above 50% on the exam (including open-ended and multiple-choice questions). Grading scale with percentage distribution: • Very good (bdb; 5.0): achieving the intended learning outcomes at a minimum of 91% • Good plus (db+; 4.5): achieving the intended learning outcomes at a minimum of 81% • Good (db; 4.0): achieving the intended learning outcomes at a minimum of 71% • Satisfactory plus (dst+; 3.5): achieving the intended learning outcomes at a minimum of 61% • Satisfactory (dst; 3.0): achieving the intended learning outcomes at a minimum of 51% • Unsatisfactory (ndst; 2.0): failure to achieve the intended learning outcomes
Classes	Passing is based on written quizzes (including open-ended and multiple-choice questions) and responses on a specific topic. Grading scale with percentage distribution: • Very good (bdb; 5.0): achieving the intended learning outcomes at a minimum of 91% • Good plus (db+; 4.5): achieving the intended learning outcomes at a minimum of 81% • Good (db; 4.0): achieving the intended learning outcomes at a minimum of 71% • Satisfactory plus (dst+; 3.5): achieving the intended learning outcomes at a minimum of 61% • Satisfactory (dst; 3.0): achieving the intended learning outcomes at a minimum of 51% • Unsatisfactory (ndst; 2.0): failure to achieve the intended learning outcomes

Activities	Credit conditions
Laboratories	1. The exercises are conducted according to the schedule in designated time blocks. Before the start of laboratory exercises, the workshop program, assessment methods, and requirements for passing individual exercises are presented, as well as the conditions for passing the entire workshop. 2. It is the student's obligation to regularly attend the exercises. Absences may be excused upon presentation of a medical certificate or for random reasons. A student can make up a missed exercise if the absence was excused, within two weeks after returning to classes and if there are available make-up slots in other exercise groups. In case of multiple (excused) absences, the decision is made by the exercise supervisor after consultation with the lecturer and dean. 3. A student does not have the right to make up for unexcused absences, which may result in a failure to pass the workshop. 4. Familiarity with occupational health and safety rules and a commitment to strictly adhere to them are the fundamental obligations of the participant. The student confirms their knowledge of the workshop regulations by signing them. Blatant violations of occupational health and safety rules may result in immediate expulsion from the workshop without the possibility of making up missed classes. 5. Before starting an exercise, the student is obliged to familiarize themselves with the hazards of the chemical compounds used. During the exercises, the student is required to apply all safety measures. Wearing protective goggles and clothing is mandatory. Taking breaks and leaving the workshop during the session is possible after securing the workstation and notifying the assistant conducting the exercises. 6. Keeping laboratory notes is mandatory. Passing the exercise must be confirmed by the assistant's entry in the laboratory work record. 7. The student is financially responsible for the laboratory equipment entrusted to them. Passing the workshop is conditional, among other things, on returning the laboratory equipment stored in lockers or borrowed on reverse, as well as settling any damaged or broken equipment. 8. The workshop program is divided into two parts: ◦ Part 1: Laboratory Techniques - The student learns how to set up synthesis experiments and familiarizes themselves with purification techniques of organic substances such as crystallization, filtration, simple and/or fractional distillation, steam distillation, extraction, melting point determination, operation of a rotary evaporator, and thin-layer chromatography (TLC). ◦ Part 2: Synthetic Part - The student performs syntheses of specified preparations, including one- or two-step syntheses using various laboratory techniques (it is recommended to perform 5 preparations). The student also familiarizes themselves with practical aspects of spectroscopy (FT-IR, NMR). 9. Within the laboratory exercises, there will be 2 mandatory lectures on "Introduction to UV, IR, NMR Spectroscopy, and Mass Spectrometry" held on common dates for all groups, except during laboratory exercise hours (October 19th and 26th, 2022). After each lecture, the student will be required to pass a knowledge test on the material covered during the lectures (testportal.pl). The test results will account for 30% (2 × 15%) of the final grade for the Spectroscopy Exam (see point 12c of the regulations). During the semester, the student must complete the following assessments: ◦ Occupational Health and Safety Exam (first class, pass/fail), ◦ Laboratory Techniques Exam, which will take place in the twelfth week of classes within designated time slots according to the workshop schedule (written exam graded on a scale), ◦ Spectroscopy Exam (oral exam graded on a scale), the grade for the exam accounts for 70% of the final grade for spectroscopy, and the remaining 30% is based on the results of knowledge tests on the material covered during the Spectroscopy lectures, as mentioned in point 11 of the regulations. ◦ Independently prepare preparations chosen by the assistant. 10. If a student does not pass one of the assessments mentioned in point 12 (laboratory techniques and/or spectroscopy) or passes them but is not satisfied with the grade from the first attempt, they have the right to retake the assessment, which should be scheduled with the instructor no later than two weeks after the end of the laboratory sessions. 11. The evaluation of the preparation takes into account both the procedure of conducting the experiment and the student's theoretical preparation for the exercise: ◦ The assessment of knowledge related to the performed exercise accounts for 40% of the final grade for the preparation. The student must demonstrate knowledge of the mechanism of the conducted reaction, the hazards of the chemical compounds used and obtained, applied laboratory techniques, as well as knowledge of the physical and chemical properties of discussed functional groups (theoretical aspects indicated by the assistant). Insufficient knowledge related to the exercise and occupational health and safety rules authorizes the instructor to prohibit the student from performing the exercise. ◦ The assessment of the exercise performance accounts for 60% of the final grade for the preparation. The assessment includes the completed laboratory journal/laboratory work record (yield, purity of the obtained compound, spectral characteristics, etc.), as well as the student's commitment, diligence in performing the preparation, the ability to analyze the obtained results, and formulating proper conclusions. 12. The final grade is the arithmetic mean of the grades obtained for the Laboratory Techniques Exam, Spectroscopy Exam, and the grades for the performed preparations, assuming all component grades are positive, i.e., the student has achieved at least 50% of the possible points for the exams and preparation performance. Grading scale with corresponding percentage distribution: • excellent (5.0): achievement of at least 95% of the learning outcomes • very good plus (4.5): achievement of at least 85% of the learning outcomes • very good (4.0): achievement of at least 75% of the learning outcomes • satisfactory plus (3.5): achievement of at least 65% of the learning outcomes • satisfactory (3.0): achievement of at least 55% of the learning outcomes • unsatisfactory (2.0): failure to achieve the learning outcomes

Literature

Obligatory

1. J. Mc Murry “Organic chemistry, 11th edition” McGraw Hill; 2019
2. J. Mc Murry “Organic chemistry, 11th edition” McGraw Hill; 2019

Optional

1. T. W. Graham Solomons, Craig B. Fryhle, Scott A. Snyder "Solomons' Organic Chemistry", 12th Edition, Wiley, 2017
2. R.T. Morrison, R.N. Boyd “Organic Chemistry 6th edition” Prentice Hall, 1992

Calculation of ECTS points

Activities	**Activity hours***
Lecture	45
Classes	30
Laboratories	120
Preparation for classes	45
Reading the indicated literature	15
Report preparation	15
Preparation for the exam	45
Preparation for the assessment	60
Student workload	**Hours** 375
Number of ECTS points	**ECTS** 12

* academic hour = 45 minutes

Efekty uczenia się dla kierunku

Kod	Treść
CEN_K1_K03	The graduate is ready to correctly assessy the risks involved in conducting chemical experiments
CEN_K1_K04	The graduate is ready to understand the importance and consequences of the professional activity of a chemist and its impact on the environment and the associated responsibility for decisions taken
CEN_K1_K05	The graduate is ready to understand and appreciate the importance of professional ethics in his/her own actions and those of others
CEN_K1_U01	The graduate can use basic chemical terminology according to IUPAC and PTChem recommendations
CEN_K1_U02	The graduate can present the knowledge acquired in an accessible manner
CEN_K1_U03	The graduate can identify and justify the properties of a substance on the basis of its structure
CEN_K1_U04	The graduate can plan the implementation of chemical processes in terms of the choice of reagents and elimination of the side products formed
CEN_K1_U05	The graduate can carry out basic chemical synthesis processes
CEN_K1_U16	The graduate can apply analytical techniques to explain basic chemical and physicochemical phenomena
CEN_K1_U17	The graduate can select instrumental analysis methods to investigate specific chemical and physicochemical phenomena
CEN_K1_U19	The graduate can analyse and develop test results and prepare a final report on the chemical and physico-chemical experiments carried out
CEN_K1_U22	The graduate can prepare a summary of the analyses of the literature data carried out
CEN_K1_U23	The graduate can use information technology
CEN_K1_U24	The graduate can speak a foreign language (English) at B2 level
CEN_K1_U25	The graduate can create a presentation of a specific chemical or physicochemical problem and propose a solution to it
CEN_K1_U26	The graduate can carry out simple research tasks or expert opinions under the guidance of a mentor
CEN_K1_U27	The graduate can demonstrate the ability to make correct inferences on the basis of data from chemical or physico-chemical experiments and literature sources
CEN_K1_W01	The graduate knows and understands basic chemical laws and issues
CEN_K1_W04	The graduate knows and understands fundamental knowledge of natural sciences
CEN_K1_W05	The graduate knows and understands the mechanisms of basic chemical reactions
CEN_K1_W06	The graduate knows and understands structure of molecules and crystals
CEN_K1_W08	The graduate knows and understands the chemical properties of substances according to their structure/composition
CEN_K1_W10	The graduate knows and understands the basic processes of chemical synthesis
CEN_K1_W12	The graduate knows and understands chemical compounds, including those discovered recently