DESCRIPTION OF THE COURSE OF STUDY

Course code	**0531-2CHEM-C16-CO1**	
Name of the course in	Polish	Chemia organiczna
	English	Organic Chemistry

1. LOCATION OF THE COURSE OF STUDY WITHIN THE SYSTEM OF STUDIES

1.1. Field of study	**Chemistry**
1.2. Mode of study	**Full-time studies**
1.3. Level of study	**First-cycle studies**
1.4. Profile of study*	**General academic**
1.5. Person/s preparing the course description	**Alicja Wzorek**
1.6. Contact	**awzorek@ujk.edu.pl**

2. GENERAL CHARACTERISTICS OF THE COURSE OF STUDY

2.1. Language of instruction	**English**
2.2. Prerequisites*	**General chemistry**

3. DETAILED CHARACTERISTICS OF THE COURSE OF STUDY

3.1. Form of classes		Lectures, laboratory exerices
3.2. Place of classes		Classes in the teaching room of the UJK
3.3. Form of assessment		Lecture - exam, laboratory exercises, seminar - credit with grade
3.4. Teaching methods		Lecture, discussion, demonstration, independent experiments,
3.5. Bibliography	**Required reading**	J. McMurry, Organic Chemistry S. McMurry, Study Guide with Solutions Manual for McMurry's Organic Chemistry J. March Advanced Organic Chemistry A.I.Vogel, Textbook of Practical Organic Chemistry
	Further reading	R. T. Morrison, R. N. Boyd, Organic Chemistry J. Clayden, N. Greeves, S. Warren, Organic Chemistry

4. OBJECTIVES, SYLLABUS CONTENT AND INTENDED LEARNING OUTCOMES

4.1. Course objectives *(including form of classes)*

Presentation of the basics of organic chemistry needed for further studies of biochemistry and advanced organic chemistry. Learning the basics of the nomenclature of organic compounds, structural theory and stereochemistry. Presentation of the basic classes of organic compounds, the types of reaction and mechanisms. Practical acquisition of laboratory skills, preparation of organic compounds, their purification and identification by classical chemical analysis, determination of selected physicochemical properties.

4.2. Detailed syllabus *(including form of classes)*

Lecture: Classification of organic compounds: Functional groups, molecular and structural formula, nomenclature. Principles of theoretical organic chemistry: Classical and quantum chemical bond theory, covalent and ionic bonding, nonbonding interaction, hydrogen bonding, atomic and molecular orbitals, hybridization, electron structure of simple molecules and ions. Formal charge of oxidation. Polarization of bonds. Electronic effects - inductive and resonance. Theoretical bases for transformation of organic compounds: Classification of reactions ac-cording to changes in the substrate and the nature of reagent. Mechanism of reaction. Transition states. Carbocations, carbons, radicals and carbenes. Alkanes and cycloalkanes: nomenclature and constitutional isomers, preparation methods. Electronic and spatial structure of alkanes. Basic concepts of conformational analysis. Spatial structure of cycloalkanes. Cis-trans isomerism in cycloalkanes. Mechanism for radical substitution - selectivity of halogenation reaction. Effect of ring size on reactivity of cycloalkanes. Stereochemistry: Chirality, stereogenic center, enantiomer, diastereomers, meso compounds, racemate, relative and absolute configuration. System (R, S) Cahn, Ingold and Prelog rules. Optical isomeric of substituted biphenyl, allenes, spiranes and cyclo compounds. Compounds with steregenic centres at N,S,P and S. Stereochemistry of Reactions: Regioselective, Stereoselective, and Stereospecific Reactions. Alkenes, dienes and allenes: Nomenclature and constitutional isomerism. Preparation methods. Electronic and spatial structure. Geometric isomorphism (E, Z). Mechanism and stereochemistry of the nucleophilic addition to alkenes: the Markovnikov's rule, Hammond's postulate. Radical addition reactions, oxidation and reduction of alkenes. Diene: bond types, electron delocalization in conjugated dienes, electrophilic addition to dienes, Diels-Alder addition. Addition reactions to the triple bond, alkyne acidity. Basics. Tautomerism.

Aromatic hydrocarbons: Nomenclature of benzene and polycyclic hydrocarbons. Benzene electron dynamics, aromaticity, Hückl's rule, resonance energy. Non-benzene aromatic systems including anions and cations. Aromatic five-membered-ring heterocycles. Aromatic six-membered-ring heterocycles. Electrophilic aromatic substitution in the arenes: halogenation, nitration, sulfonation, Friedel–Crafts reactions: alkylation, acylation. The role of Lewis acids. Mechanism of electrophilic substitution: complex σ and complex π. The Effects of substituents on the reactivity of a benzene ring. Activating and deactivating substituents. Substitution Isomers of disubstituted benzene derivatives. Other reactions of arenes. Side chain reactions. Designing a synthesis of mono- di- and trisubstituted benzene derivatives. Polycyclic benzenoid hydrocarbons and their reactivity. Nucleophilic aromatic substitution reactions. Benzyne intermediate. Heteroaromatic compounds.
Alkyl halides: Nomenclature. Preparation methods. Mechanism and stereochemistry of Nucleophilic Substitution (S_N1 and S_N2) and Elimination of E1 and E2. The Zaitsev's rule. Nucleophilicity and basicity. Competition between substitution and elimination reactions. Allylic, benzylic and vinyl halides. Electrophilic and nucleophilic substitution in aryl halides. Organometallic com-pounds, and their application in organic synthesis.
Alcohols, phenols and ethers: Nomenclature. Preparation methods. Effect of hydrogen bond on physicochemical properties. Primary, secondary, and tertiary alcohols. Lucas test. Acid-base properties of alcohols. Reaction of Hydroxyl group, Mechanism for nucleophilic substitution and elimination reactions. Esters of inorganic acids. Selected polyalcohols and their reactions. Comparison of the acidity of alcohols and phenols. Electrophilic substitution of phenol and phenoxy anion. Alcohols and phenol oxidation. Basicity Ethers and complexing properties. Cleavage of C-O-C bonds in ether, selected cyclic ether and their reactions. Crown Ethers.
Carbonyl compounds (aldehydes and ketones): Nomenclature. Preparation methods. Electron structure of the carbonyl group. Keto-enol tautomerism. Nucleophilic addition of carbonyl com-pounds - mechanism, oxygen and nitrogen nucleophiles, addition of organometallic compounds. Reduction. Reactions at the α-Carbon, carbonyl condensation. The reactions of C-H, C-O, C-C, C-N, C-S, C-P, C-halogen bonds formation. α, β-unsaturated aldehydes and ketones, polycarbonyl compounds. Ketenes and quinones.
Aliphatic and aromatic carboxylic acids and their derivatives (chlorides, anhydrides, esters and amides): Nomenclature and major methods of their preparation. Structure of the carboxyl group. Physical properties of carboxylic acids and their derivatives. Hydrogen bonding in acids, acid strength, effect of substituents on acidity. Reactions and Mechanism of Nucleophilic Addi-tion at acyl group. Reaction of esterification and hydrolysis. The Hell–Volhard–Zelinski Reaction. Claisen Condensation. Unsaturated acids, dicarboxylic acids, halogeno acids, oxocarboxylic acids and their derivatives. Ethyl acetate and diethyl malonate - application in organic synthesis.
Nitrogen compounds: Nomenclature of amines. Preparation methods. Electronic and spatial structure. Acid-Base properties. Amines as nucleophiles. Alkylation and arylation. Mechanism for the reaction of amines with nitrous acid. The arene diazonium ion as an electrophile. Synthesis of substituted benzenes using arene diazonium salts. Electrophilic substitution reactions of aromatic amines. Azo dyes. Reactions of quaternary ammonium hydroxides, Hofman rule. Nitriles, nitro compounds - nomenclature, preparation methods and their reactivity. Nitrogen compounds of aliphatic compounds.
Carbohydrates: Classification and nomenclature. Optical isomers and monosaccharide configurations. Cyclic structure of monosaccharides: Haworth projection, chair conformation. Glycosides. Mutarotation. Reactivity. Reducing and Non-reducing Sugars. Anomeric Effect. Structure and properties of some di- and polysaccharides. Synthetic Sweeteners.
Amino acids, peptides and proteins: Classification and nomenclature. Synthesis of amino acids. resolution of racemic mixtures. Configuration of natural amino acids. Acid-base properties of amino acids, the isoelectric points. Strategy of Peptide Bond Synthesis. Protein structure.
Hetero-aromatic compounds: Basic types of mono- and polycyclic systems. Selected methods of preparation. Monocyclic compounds with one heteroatom (furan, thiophene, pyrrole) - acid-base properties, electrophilic and nucleophilic substitution reactions. Reactivity of pyridine and substituted pyridines (alkyl, hydroxy, amino) and N-oxide pyridine. Quinoline. Some heteroaromatic compounds with multiple heteroatoms (imidazole, pyrazole, pyrimidine, purine). Other issues: Rearrangement reaction. Pericyclic reactions. Planning strategy for organic synthesis. Spectroscopic methods for identification of organic compounds: IR, NMR.
SEMINAR: Strengthening and expanding the content of the lectures by solving problems. Training in writing of the mechanism of reactions. Design of the synthesis for selected organic com-pounds.
LABORATORY: The student is acquainted with the basic techniques and operations used in the organic chemistry laboratory for the isolation, purification and identification of reaction products. Training in safe handling of hazardous chemicals and the selection and utilization of chemical waste. Practical implementation of several syntheses of organic compounds. Identification of the organic compounds obtained.

4.3 Intended learning outcomes

Code	A student, who passed the course	Relation to learning outcomes
within the scope of **KNOWLEDGE:**		
W01	Student knows the basics of organic chemistry needed to understand and study biochemistry	CHEM1A _W01
W02	Knows the rules of nomenclature of organic compounds, describes their structure and stereochemistry	CHEM1A _W04
W03	Recognizes types of reactions of organic compounds and writes their mechanisms.	CHEM1A _W04

W04	Identifies organic compounds based on physicochemical and analytical properties	CHEM1A _W04
within the scope of **ABILITIES:**		
U01	Student classifies basic organic compounds	CHEM1A _U01
U02	Student analyzes the structural properties and the stereochemistry of the compounds	CHEM1A _U04
U03	Student writes the reactions and mechanisms of basic classes of organic compounds	CHEM1A _U04
U04	Student possess practical skills in the preparation of various compounds	CHEM1A _U10
U05	Demonstrates creativity in team work	CHEM1A_U14
within the scope of **SOCIAL COMPETENCE:**		
K01	Is aware of their level of knowledge and is actively engaged in self-education.	CHEM1A _K01
K02	Is responsible for the assigned equipment necessary to perform practical tasks.	CHEM1A _K02
K03	Is conscious of the harmful effects of organic compounds on the environment and health.	CHEM1A _K02

4.4. Methods of assessment of the intended learning outcomes

Teaching outcomes *(code)*	**Method of assessment (+/-)**																				
	Exam oral/written*			**Test***			**Project***			**Effort in class***			**Self-study***			**Group work***			**Others* e.g. standardized test used in e-learning**		
	Form of classes			***Form of classes***			***Form of classes***			***Form of classes***			***Form of classes***			***Form of classes***			***Form of classes***		
	L	*C*	*...*	*L*	*C*	*...*	*L*	*C*	*...*	*L*	*C*	*...*	*L*	*C*	*...*	*L*	*C*	*...*	*L*	*C*	*...*
W01	+				+						+			+							
W02	+				+						+			+							
W03	+				+						+			+							
W04						+															
U01	+				+						+			+							
U02	+				+						+			+							
U03	+				+						+			+							
U04						+									+						
K01	+														+		+	+			
K02															+		+	+			
K03															+		+	+			
K04															+		+	+			

delete as appropriate

4.5. Criteria of assessment of the intended learning outcomes

Form of classes	**Grade**	**Criterion of assessment**
lecture (L) (including e-learning)	**3**	Exam : the student must earn at least 60% of the total points.
	3,5	Exam : the student must earn 70% of the total points.
	4	Exam : the student must earn 80% of the total points.
	4,5	Exam : the student must earn 90% of the total points.
	5	Exam : Student gain more than 95% of total points.
classes (C)* (including e-learning)	**3**	Tests : the student must earn at least 60% of the total points.
	3,5	Tests : the student must earn 70% of the total points.
	4	Tests : the student must earn 80% of the total points.
	4,5	Tests : the student must earn 90% of the total points.
	5	Tests : Student gain more than 95% of total points.
laboratory (...)* (including e-learning)	**3**	Student performed all practical tasks; wrote reports with corrections; earned 60% of correct answers.
	3,5	Student performed all practical tasks; wrote reports with corrections; earned 70% of correct answers.
	4	Student performed all practical tasks; wrote reports without corrections; earned 80% of correct answers.
	4,5	Student performed all practical tasks; wrote reports without corrections; earned 90% of correct answers.
	5	Student performed all practical tasks; wrote reports without corrections; earned >95% of correct answers.

5. BALANCE OF ECTS CREDITS – STUDENT'S WORK INPUT

Category	Student's workload	
	Full-time studies	Extramural studies
NUMBER OF HOURS WITH THE DIRECT PARTICIPATION OF THE TEACHER /CONTACT HOURS/	**225**	**130**
*Participation in lectures**	**60**	**40**
*Participation in classes, seminars, laboratories**	**165**	**90**
INDEPENDENT WORK OF THE STUDENT/NON-CONTACT HOURS/	**75**	**170**
*Preparation for the lecture**	**10**	**20**
*Preparation for the classes, seminars, laboratories**	**30**	**80**
*Preparation for the exam/test**	**30**	**70**
TOTAL NUMBER OF HOURS	**300**	**300**
ECTS credits for the course of study	**12**	**12**

delete as appropriate

Accepted for execution *(date and legible signatures of the teachers running the course in the given academic year)*

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