Formularz opisu przedmiotu (formularz sylabusa) na studiach wyższych, doktoranckich, podyplomowych i kursach dokształcających

A. Ogólny opis przedmiotu

Nazwa pola	Komentarz
Name of the subject (in Polish and English)	**Chemia organiczna** **Organic chemistry**
Unit offering the subject	Faculty of Chemistry
Unit for which the subject is offered	Faculty of Chemistry
Subject code	**0600-S1-O-CORGa, 0600-S1-O-CORGb**
ERASMUS code	**13.3**
Number of ECTS credits	14
Method of assessment	Lecture – written examination Tutorial – graded credit Laboratory – graded credit
Language of instruction	English
Designation whether a subject may be credited more than once	No
Allocation of the subject to subject groups	*Obligatory*
Total student workload	*Contact hours with teacher:* - participation in lectures - 75 hrs - participation in tutorial - 30 hrs - participation in laboratory - 105 hrs *Self-study hours:* - preparation for laboratory - 40 hrs - preparation for colloquia - 60 hrs - preparation for the exam – 45 hrs - consultation and work with an academic teacher - 5 hrs Altogether: 360 hrs/25 hrs = 14 ECTS
Learning outcomes - knowledge	Student *W1*: knows the basic laws and chemical nomenclature – K_W01 *W2*: possesses a basic knowledge of the functional groups of organic compounds and reaction mechanisms – K_W07 *W3*: is familiar with the role of experiment and computer simulation in chemical processes – K_W04
Learning outcomes - skills	Student *U1*: is capable of recognize the functional groups of organic compounds and carries out the experiments in organic chemistry – K_U07 *U2*: is able to use the chemical nomenclature and concepts of general chemistry - K_U01
Learning outcomes - social competencies	Student *K1*: analytical thinking: independently and effectively works with a large amount of information, recognizes relationships between phenomena, and draws conclusions using the rules of logic properly – K_K01 *K2*: conscientiousness and accuracy: is focused on the best execution

	of task, takes care of the detail, is systematic – K_K03 *K3*: striving for development: is focused on continually acquiring new knowledge, skills, and experience; understands the need for continuous improvement and raise the professional competence; identifies the limits of his own knowledge and understands the need for further education – K_K05 *K4*: perseverance and consistency: is able to work systematically and has a positive approach to the difficulties standing in the way of the objective pursued; respects deadlines; understands the need for regular work on any project – K_K06
Teaching methods	**Lecture**: conventional lecture with the use of multimedia presentation **Laboratory**: syntheses and analyzes of selected compounds, completed with preparation of elaborations **Tutorial**: exercises involving the solving problems in organic chemistry applying elements of lecture and discussion
Prerequisites	Basic knowledge of general chemistry, analytical chemistry, and instrumental methods
Brief description of the subject	The subject includes content related to the chemistry of carbon compounds and aims to familiarize students with basic information on the types of organic compounds and their reactions and experimental techniques in this field
Complete description of the subject	**Lecture**: The essence organic chemistry. The importance of carbon compounds to humans. The genesis of coal. Allotropic variety of carbon. Fullerenes. Carbon nanotubes. Coal as fuel. **Alkanes**: Alkanes as a class of hydrocarbons. Laboratory and industrial methods for the synthesis of alkanes. Bergius and Fischer-Tropsch processes. Oil. Natural gas. Refining of crude oil. The octane and cetane numbers of fuels. Nomenclature of alkanes. Conformations of alkanes. Combustion of alkanes. Free radical bromination and chlorination of alkanes. **Cycloalkanes**: Cycloalkanes nomenclature. Cyclopropane structure. The stability of cycloalkanes. Bayer tensions theory. Conformations of cycloalkanes. Stereochemistry of the substituted cyclohexane derivatives. Disintegration of carbon-carbon covalent bond. Carbocation and free radical. **Alkenes**: Structure of ethene. Alkenes nomenclature. Laboratory methods for the preparation of alkenes. Dehydration of alcohols as a method for the synthesis of alkenes. E1 and E2 elimination reactions. Dehydrohalogenation of alkyl halides. Debromination of vicinal dibromides. Addition reactions to the olefins. Mechanism of electrophilic addition to alkenes. Hydrogenation of alkenes. Addition of metal hydroxide to form alkenes. Markovnikov's rule and the exceptions to this rule. Addition of sulfuric acid. Bromination reaction. Bromonium ion. Halohydrines. Addition of water to the olefins. The epoxidation of olefins and acidic hydrolysis. Dimerization of alkenes. Oxidative degradation of alkenes. Ozonolysis. The oxidation of alkenes using $KMnO_4$ and OsO_4. Oxymercuration-demercuration of alkenes. Hydroboration-oxidation of alkenes. Isomerization of boroorganic compounds. **Dienes**: Types of dienes. Methods for the synthesis of dienes. Chemical properties of conjugated dienes. Resonance of conjugated dienes. 1,2-Addition and 1,4-addition of conjugated dienes. Allyl cation and its construction. The Diels-Alder reaction. Stereochemical aspects of the Diels-Alder reaction. **Alkynes**: Nomenclature. Physical and chemical properties. Syn and anti addition of hydrogen to alkynes. The acidity of acetylene and terminal alkynes. Silver and copper acetylides. Synthesis of alkynes by

	the elimination of the vicinal dibromides. Synthesis of alkynes from ketones. Addition of halogens to alkynes. Addition of hydrogen halides to alkynes. Addition of water to alkynes. Tautomerism. The oxidative disintegration of alkynes. **Nucleophilic substitution**: SN1 and SN2 mechanisms. Influence of various factors on the reactions. Energy profiles and the transition state structures for nucleophilic substitution. Competition between nucleophilic substitution reactions and elimination. **Isomerism**: Optical isomerism. Stereochemistry of organic compounds. Specific rotation. Concepts: enantiomer, racemate, diastereomer, meso compound. Fischer projection. Substituents priority rules. **Aromatic compounds**: Structure of benzene. Reactions of benzene and differences with other hydrocarbons. Stability of benzene. Aromaticity. The Hückel rule. Molecular orbital description of benzene. Annulenes. Aromatic ions. Polycyclic aromatic compounds. Heterocyclic aromatic compounds. The mechanism of aromatic electrophilic substitution. Aromatic bromination and chlorination. Nitration and sulfonation of aromatic rings. The Friedel-Crafts alkylation and acylation reactions. Reactivity of aromatic rings. Alkyl derivatives of benzene and their reactions. Halogenation of alkylbenzene side chains. Alkenyl benzene derivatives and their addition reactions. Benzyl radical and cation. Organometallic compounds. Organic compounds of lithium, magnesium, boron, zinc, mercury, and copper - synthesis, structure, properties, and applications. Alcohols, phenols, ethers, crown ethers. Aldehydes and ketones, enols and enolate ions, aldol reactions. Carboxylic acids, chlorides, and anhydrides. Esters, esterification, condensation ester, syn-elimination. Amides, sulfonamides, chemotherapy - historical. Amines, quaternary ammonium salts and hydroxides. Hofmann elimination, phase transfer catalysis, enamine. Dicarbonyl compounds, acetoacetic and malonic esters. Reactive intermediates - carbocation, carbanion, free radical, carbene, nitrene, benzyne. **Macromolecules**: The main methods of synthesis of macromolecules. The polymerization and polycondensation. The most important class of polymers. **Natural compounds and biopolymers**: Carbohydrates - classification, monosaccharides - chain and cyclic forms, mutarotation, reactions: building and reconstruction, disaccharides, polysaccharides. Amino acids - structure, acid-base, isoelectric point, and synthesis reactions. Polypeptides - structure determination. Synthesis of polypeptides. **Laboratory**: Techniques of laboratory work and determination of physical constants: crystallization, distillation (simple, fractional and steam distillation), extraction and sublimation. Thin layer chromatography (TLC), gas chromatography (GC) and infrared analysis (IR). Realization of 8 preparations in the field of the substitution reaction, Diels-Alder addition, elimination (dehydration), oxidation, reduction, electrophilic substitution on the aromatic ring, esterification and condensation. Complete three tasks in the field of qualitative analysis of organic compounds. **Tutorial**: These classes are dedicated to solving of simple problems with the basics of organic chemistry discussed in the lecture, nomenclature of organic compounds and the reaction mechanisms occurring in this class of compounds. Nucleophilic substitution and elimination reactions, addition to the double bond, electrophilic substitution on the aromatic ring and the aldol condensation will be discussed.

Literature	Basic literature: 1. T. W. G. Solomons, C. B. Fryhle, *Organic Chemistry*, 7th Ed., J. Wiley, New York, 2000. 2. J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, Oxford University Press, Oxford, 2001. 3. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*, 5th Edition, LongmanScientific&Technical, Essex 1989. 4. R. L. Shriner, Ch. K.F. Hermann, T. C. Morrill, D. Y. Curtis, R. C. Fuson, *The Systematic Identification of Organic Compounds*, 7th Edition, J. Wiley, New York, 1998. Additional literature: 1. J. McMurry, *Chemia organiczna*, PWN, Warszawa, 2000. 2. R. T. Morrison, R. N. Boyd, *Chemia organiczna*, PWN, Warszawa, 1990. 3. P. Tomasik, Mechanizmy reakcji organicznych, PWN, Warszawa 1998. 4. Laboratorium chemii organicznej, praca zbiorowa pod redakcją Piotra Kowalskiego, WNT, Warszawa, 2004.
Assessment methods & criteria	Assessment methods: **Lecture**: written examination – the final assessment is the sum of points scored in the exam (75%), laboratory (15%) and tutorial (10%) - W2, W3, U1, U2, K1, K2, K3, K4. **Laboratory**: credit on the basis of laboratory exercises and elaborations. Nine written tests per semester - W1, W2, W3, U1, U2, continuous evaluation of the student in the laboratory - K1, K2, K3, K4. **Tutorial**: credit on the basis of two written tests per semester - W2, W3, U1, U2, continuous evaluation of the student in the classroom - K1, K2, K3, K4. Assessment criteria: fail - 50% < satisfactory - 50-60% satisfactory plus - 61-65% good - 66-75% good plus - 76-80% very good - 81% >
Work placement	Not applicable

B Opis przedmiotu cyklu

Nazwa pola	Komentarz
Didactic cycle	*IV and V semester*
Method of assessment of the subject in the cycle	*Lecture - written examination*
Type of classes, number of hours of classes and methods of assessment	*Lecture - 75 hrs, examination* *Laboratory – 105 hrs, credit with a grade* *Tutorial – 30 hrs, credit with a grade*
Subject coordinator	*dr Agnieszka Tafelska-Kaczmarek*
Subject teachers	*Dr Agnieszka Tafelska-Kaczmarek – lecture* *Dr Marek Krzemiński – laboratory* *Dr Agnieszka Tafelska-Kaczmarek – tutorial*
Nature of the subject	*Obligatory subject*
Limit of places available in each group	*Lecture: one group includes all students of the course* *Laboratory: groups may have up to 30 students* *Tutorial: groups may have up to 24 students*

Time and place	*Lecture: lecture room, the dates according to schedule* *Laboratory: Organic Chemistry Laboratory, the dates according to schedule* *Tutorial: seminar room, the dates according to schedule*
Learning outcomes	As in part A
Assessment methods & criteria	As in part A
List of topics	**Lecture**: 1. The nature of organic compounds 2. Alkanes and cycloalkanes 3. Stereochemistry of alkanes and cycloalkanes 4. Alkenes: structure, reactivity, and synthesis 5. Alkynes: structure, reactivity, and synthesis 6. Nucleophilic substitutions and eliminations 7. Benzene and aromaticity 8. Chemistry of benzene: electrophilic aromatic substitution 9. Alcohols and thiols 10. Ethers and epoxides 11. Aldehydes and ketones: nucleophilic addition reactions 12. Carboxylic acids 13. Carboxylic acid derivatives 14. Carbonyl alpha-substitution reactions 15. Carbonyl condensation reactions 16. Carbohydrates: classification and reactions 17. Aliphatic amines 18. Arylamines and phenols 19. Amino acids, peptides, and proteins 20. Lipids 21. Heterocycles and nucleic acids **Laboratory**: 1. Simple distillation, fractional, and under reduced pressure, refractometry, polarimetry 2. Crystallization, melting point determination 3. Extraction and sublimation 4. TLC, GC chromatography 5. Tert-butyl chloride; tert-amyl chloride 6. Adipic acid; anthracenesuccinic anhydride 7. Isoamyl acetate; isobutyl acetate 8. Cyclohexene; the dehydration of 2-methyl-2-butanol 9. 7,7-Dichloronorcarane; sodium borohydride reduction of camphor 10. 1-Nitronaphthalene, tert-butyltoluene 11. Diphenylmethanol, triphenylmethanol 12. 3,5-Diphenyl-4,5-dihydroisoxazole, 4,5-diphenyl-2,2-dimethyl[1,3]dioxolane 13-15. Qualitative analysis of organic compounds **Tutorial**: Nomenclature of organic compounds Constitutional isomerism and stereoisomerism Enantiomers, diastereomers, Cahn-Ingold-Prelog rule Nucleophilic substitution reactions S_N1 and S_N2 Elimination reactions E1 and E2 Free radical halogenation of alkanes Addition reactions to a double bond Electrophilic substitution on the aromatic ring: chlorination, bromination, nitration, sulfonation, Friedel-Crafts reactions The aldol condensation, Claisen condensation, syntheses from

	acetoacetic and malonic esters Reactions of acids and their derivatives Reactions of amines Structures of sugars and their reactions
Teaching methods	As in part A
Literature	As in part A