COURSE UNIT DESCRIPTION

Course unit title	
Organic Chemistry I	

Lecturer(s)	Department
Dr. Rimantas Vaitkus	Dept. Organic Chemistry, Vilnius University

Cycle	Type of the course unit
First	

Mode of delivery	Period of delivery	Language of instruction
Face to face	Autumn	English

Prerequisites and co-requisites
General chemistry (prerequisites), Quantum chemistry (co-requisites).

Number of credits	Student's total workload	Contact hours	Self-study hours
10	264	64	200

Programme Learning Outcomes to be developed.
A1. will apply appropriate terminology, nomenclature, units of measurement used in describing chemical substances and their structure. A3. will characterise the main reactions of inorganic, organic and biologically active substances. A7. will be able to explain physical phenomena and apply them for the examination of chemical substances. B3. will choose and compare the most appropriate materials and reaction conditions to achieve a specific goal B5. will synthesize materials using common methods; will describe various methods of synthesis. B6. will work with chemicals safely. B8. will be able to conduct standard laboratory procedures and use laboratory equipment. C1. will apply theoretical knowledge in solving quantitative and qualitative problems of both familiar and unfamiliar nature. C2. will plan problem-solving strategies. C3. will evaluate and mathematically process the data.

Learning outcomes of the course unit	Teaching and learning methods	Assessment methods
	Lectures;	

After successful completion of this course student should be able to: • Draw Lewis structures of organic compounds and calculate formal charges; • Draw possible resonance structures for neutral and charged organic species. Draw resonance hybride structures. • Identify functional groups in organic molecules; • Predict the polarity, solubility and other physical properties of organic molecules; • Predict the geometry of organic molecules; • Name organic compounds; • Draw step-by-step reaction mechanisms for most of organic reactions; • Assess the stability of reactive intermediates; • Identify the stereogenic atoms and name them according to R,S-nomenclature; • Determine the most stable isomers of unsaturated organic molecules; • Compare the stability of conformers; • Explain the stereochemical outcome of organic reactions; • Explain the regioselectivity of organic reactions; • Identify nucleophilic and electrophilic atoms in organic molecules and predict their reactivity; • Write the reaction mechanisms using the notation of electron pair movement; • Propose the retrosynthetic plan for given organic compound; • Prepare and present laboratory work report; • Synthesize organic molecules and assess their purity; • Read chemical text in English;	Individual problem solving; Problem solving classes (tutorials); ; Textbook reading.	One midterm exam (multiple choice tasks, short answer tasks and open answer tasks). Final exam (writing chemical reactions and their mechanism, rational explanation of the reaction outcome based on the reaction mechanism, identification of product's stereochemistry).

Topics	**Contact work hours**						**Time and tasks of self-study**	
	Lectures	Consultations	Seminars	Tutorials	Laboratory work	Total contact hours	Self-study	**Tasks**
1. **Introduction**. Course objectives. History of organic chemistry.	2							
2. **Structure and Bonding**. Lewis Structures. Resonance. Determining Molecular Shape. Drawing Organic Structures. Hybridization. Bond Length and Bond Strength. Electronegativity	2		1					Textbook reading. Problem solving.

and Bond Polarity. Polarity of Molecules								
3. **Acids and Bases**. Brønsted–Lowry Acids and Bases. Reactions of Brønsted–Lowry Acids and Bases. Acid Strength and pKa. Predicting the Outcome of Acid–Base Reactions. Factors That Determine Acid Strength. Common Acids and Bases. Lewis Acids and Bases	2		1					Textbook reading. Problem solving. Preparation of laboratory work reports.
4. **Functional Groups**. An Overview of Functional Groups. Intermolecular Forces. Physical Properties. Functional Groups and Reactivity	2		1					Textbook reading. Problem solving. Preparation of laboratory work reports.
5. **Alkanes**. Alkanes—An Introduction. Cycloalkanes. An Introduction to Nomenclature. Naming Alkanes. Naming Cycloalkanes. Common Names. Physical Properties of Alkanes. Conformations of Acyclic Alkanes—Ethane. Conformations of Butane. An Introduction to Cycloalkanes. Cyclohexane. Substituted Cycloalkanes. Radical halogenation	4		1					Textbook reading. Problem solving. Preparation of laboratory work reports.
6. **Stereochemistry**. The Two Major Classes of Isomers. Chiral and Achiral Molecules. Stereogenic Centers. Stereogenic Centers in Cyclic Compounds. Labeling Stereogenic Centers with R or S. Diastereomers. Meso Compounds. R and S Assignments in Compounds with Two or More Stereogenic Centers. Disubstituted Cycloalkanes	4		1					Textbook reading. Problem solving.

7. **Understanding Organic Reactions**. Writing Equations for Organic Reactions. Kinds of Organic Reactions. Bond Breaking and Bond Making. Bond Dissociation Energy. Thermodynamics. Enthalpy and Entropy. Energy Diagrams. Energy Diagram for a Two-Step Reaction Mechanism. Kinetics	2		1					Textbook reading. Problem solving.
8. **Alkyl Halides and Nucleophilic Substitution.** Introduction to Alkyl Halides. Nomenclature. Physical Properties. Interesting Alkyl Halides. The Polar Carbon–Halogen Bond. General Features of Nucleophilic Substitution. The Leaving Group. The Nucleophile. Possible Mechanisms for Nucleophilic Substitution. Two Mechanisms for Nucleophilic Substitution. The SN2 Mechanism. Application: Useful SN2 Reactions. The SN1 Mechanism. Carbocation Stability. The Hammond Postulate. When Is the Mechanism SN1 or SN2? Vinyl Halides and Aryl Halides	4		2					Textbook reading. Problem solving. Preparation of laboratory work reports.
9. **Alkyl Halides and Elimination Reactions**. General Features of Elimination. Alkenes—The Products of Elimination Reactions. The Mechanisms of Elimination. The E2 Mechanism. The Zaitsev Rule. The E1 Mechanism 8.7 SN1 and E1 Reactions. Stereochemistry of the E2 Reaction. When Is the Mechanism E1 or E2? E2 Reactions and Alkyne Synthesis. When Is the Reaction SN1, SN2, E1, or E2?	4		1					Textbook reading. Problem solving.

10. **Alcohols, Ethers, and Epoxides**. Introduction. Structure and Bonding. Nomenclature. Physical Properties. Interesting Alcohols, Ethers, and Epoxides. Preparation of Alcohols, Ethers, and Epoxides. General Features—Reactions of Alcohols, Ethers, and Epoxides. Dehydration of Alcohols to Alkenes. Carbocation Rearrangements. Dehydration Using POCl3 and Pyridine. Conversion of Alcohols to Alkyl Halides with HX. Conversion of Alcohols to Alkyl Halides with SOCl2 and PBr3. Tosylate—Another Good Leaving Group. Reaction of Ethers with Strong Acid. Reactions of Epoxides	4		1					Textbook reading. Problem solving.
11. **Alkenes**. Introduction. Calculating Degrees of Unsaturation. Nomenclature. Physical Properties. Interesting Alkenes. Lipids. Preparation of Alkenes. Introduction to Addition Reactions. Hydrohalogenation—Electrophilic Addition of HX. Markovnikov's Rule. Stereochemistry of Electrophilic Addition of HX. Hydration—Electrophilic Addition of Water. Halogenation—Addition of Halogen. Stereochemistry of Halogenation. Halohydrin Formation. Hydroboration–Oxidation	4		1					Textbook reading. Problem solving. Preparation of laboratory work reports
12. **Alkynes**. Introduction. Nomenclature. Physical Properties. Interesting Alkynes. Preparation of Alkynes. Introduction to Alkyne Reactions. Addition of Hydrogen	2		1					Textbook reading. Problem solving.

Halides. Addition of Halogen. Addition of Water. Hydroboration–Oxidation. Reaction of Acetylide Anions								
13. **Oxidation and Reduction**. Introduction. Reducing Agents. Reduction of Alkenes. Application: Hydrogenation of Oils. Reduction of Alkynes. The Reduction of Polar C–X σ Bonds. Oxidizing Agents. Epoxidation. Dihydroxylation. Oxidative Cleavage of Alkenes. Oxidative Cleavage of Alkynes. Oxidation of Alcohols	2		1					Textbook reading. Problem solving.
14. **Conjugation, Resonance, and Dienes**. Conjugation. Resonance and Allylic Carbocations. Common Examples of Resonance. The Resonance Hybrid. Electron Delocalization, Hybridization, and Geometry. Conjugated Dienes. Interesting Dienes and Polyenes. The Carbon–Carbon σ Bond Length in 1,3-Butadiene. Stability of Conjugated Dienes. Electrophilic Addition: 1,2- Versus 1,4-Addition. Kinetic Versus Thermodynamic Products. The Diels–Alder Reaction. Specific Rules Governing the Diels–Alder Reaction (endo rule).	4		1					Textbook reading. Problem solving. Preparation of laboratory work reports
15. **Benzene and Aromatic Compounds**. Background. The Structure of Benzene. Nomenclature of Benzene Derivatives. Interesting Aromatic Compounds. Benzene's Unusual Stability. The Criteria for Aromaticity—Hückel's Rule. Examples of Aromatic Compounds. Electrophilic	4		1					Textbook reading. Problem solving. Preparation of laboratory work reports

Aromatic Substitution. Electrophilic Aromatic Substitution. The General Mechanism. Halogenation.Nitration and Sulfonation. Friedel–Crafts Alkylation and Friedel–Crafts Acylation. Substituted Benzenes. Electrophilic Aromatic Substitution of Substituted Benzenes. Why Substituents Activate or Deactivate a Benzene Ring. Orientation Effects in Substituted Benzenes. Limitations on Electrophilic Substitution Reactions with Substituted Benzenes. Disubstituted Benzenes. Synthesis of Benzene Derivatives. Halogenation of Alkyl Benzenes. Oxidation and Reduction of Substituted Benzenes								
16. **Carboxylic Acids and the Acidity of the O–H Bond**. Structure and Bonding. Nomenclature. Physical Properties. Interesting Carboxylic Acids. Aspirin, Arachidonic Acid, and Prostaglandins. Preparation of Carboxylic Acids. Reactions of Carboxylic Acids—General Features. Carboxylic Acids—Strong Organic Brønsted–Lowry Acids. Inductive Effects in Aliphatic Carboxylic Acids. Substituted Benzoic Acids. Sulfonic Acids	2		1					Textbook reading. Problem solving. Preparation of laboratory work reports
Total	**48**		**16**					

Assesment strategy	**Weight %**	**Assessment period**	**Assessment criteria**
Mid-term exam (1 time)	40%	November	Open answer questions.
Final Exam	50%	January	Open answer questions.

Reading list

Author	**Year of publ.**	**Title**	**Publisher**	**Number of volumes in the**

				library of faculty
Main reading list				
T. W. G. Solomons, C. B. Fryhle	2000, 2004, 2008	Organic Chemistry	Wiley	71
J. McMurry	2003 2004	Organic Chemistry	Brooks/Cole	16
Additional reading list				
J. Clayden, N. Greeves, S. Warren, P. Wothers	2007	Organic Chemistry	Oxford University Press	14