

Field of **CHEMICAL ENGINEERING**

Approved in the CSD meeting _____

Doctoral School Director
Prof. habil. PhD. Eng. Mihai Albulescu

SYLLABUS

ORGANIC SYNTHESIS

Discipline category: **Advanced knowledge**

Number of hours for study: **210**

Number of credits allocated: **15**

Evaluation form: **Exam**

Content

1. Chemical bond. Atomic and molecular orbital. Polarity of bonds and molecules. Intra- and intermolecular forces.
2. Homolysis and heterolysis of organic compounds. Electronic, steric, catalytic, surface, initiators, solvents effects.
3. Correlations between structure and physical properties; intermolecular forces, melting, boiling, association, solubilization. Acids and bases; superacid systems. Acid-base equilibria. Hard and soft acids.
4. Alkanes. Structure, conformation, configuration; natural sources and methods of preparation; physical properties.
5. Alkan reactions; halogenation, oxidation, pyrolysis; the mechanisms of reactions. Free radicals of carbon. Hyperconjugation.
6. Stereochemistry: asymmetric carbon and chirality; polarimetry, optical activity, enantiomers, racemic mixture, diastereoisomers, mezo structures, CIP convention, polarimetry.
7. Alkenes: structure, physical properties, isomerism, industrial methods of obtaining and preparation in the laboratory.
8. Alkenes reactions: hydrogenation, thermodynamic stability; electrophilic addition of acids, water, halogens, hypohalogenic acids, dimerization and oligomerization of alkenes; polymerization of alkenes; oxidation of alkenes; electrophilic addition of alkanes to alkenes. Mechanisms: carbocation and halonium ion, regioselectivity.
9. Radical reactions of alkenes: radical addition, polymerization, oxidation and autooxidation; allyl substitution: allyl radical.
10. Acetylenes: structure, physical properties, industrial methods of production and preparation in the laboratory. General reactions: acidity, electrophilic addition, oligomerization; alkylation of alkynes.

11. Cycloalkanes: structure, conformation, configuration, stereoisomer; thermodynamic stability of cycloalkanes; angular, torsional and van der Waals tension; Bayer theory; methods of production and general reactions.
12. Conjugated dienes: structure, methods of production; electrophilic and radical addition; kinetic and thermodynamic controlled reactions; diels Alder cycloaddition; polymerization of conjugated dienes; natural and synthetic rubber.
13. Aromatic hydrocarbons: structure, aromatic character; the Huckel rule; data that contradict the Kekule structure of benzene; examples; physical properties.
14. Aromatic electrophilic substitution: generalities; isotopic effect; mechanism; electrophilic agents; equilibria; electrophilic substitution reactions: nitration, sulfonation, halogenation, Friedel - Crafts alkylation.
15. Relative reactivity and orientation of electrophilic substitution in mono- and disubstituted benzene
16. Sources and obtaining methods of aromatic hydrocarbons
17. Alkyl and alkenyl-aromatic hydrocarbons: general physical and chemical properties: radical and electrophilic substitution; benzylic radicals and cations
18. Polycyclic aromatic hydrocarbons: structure, physical and chemical properties: oxidation reduction, electrophilic substitution, electrophilic substitution orientation and addition
19. Types of halogenated derivatives: physical properties, obtaining. General reactions of halogenated derivatives, examples
20. Nucleophilic substitution (SN1 and SN2) and elimination (E1 and E2) reactions; mechanism, kinetics, stereochemistry, examples of factors that influence the reactions
21. Alcohols. Structure, classification, nomenclature. Physical properties. Methods of production. Chemical properties: C-O cleavage reactions; reactions with cleavage of the O-H bond; other types of reactions. Methods of analysis.
22. Phenols. Structure, classification, nomenclature. Physical properties. Sources and methods of production. Chemical properties (reactions of the hydroxyl group, nucleus reactions). Methods of analysis.
23. Ethers. Structure and nomenclature. Physical properties. Methods of production. Chemical properties
24. Epoxides. Structure. Methods of synthesis. Characteristic reactions.
25. Hydroperoxides and Peroxides. Classification. Structure. Physical properties. Methods of Preparation. Chemical properties
26. Organic sulfur compounds. Classification. Thiols. Structure. Physical properties. Sources and methods of synthesis. Characteristic reactions. Thioethers. Methods of synthesis. Characteristic reactions. Aliphatic and aromatic sulfonic acids. Methods of synthesis. Characteristic reactions. Other organic compounds with sulfur
27. Aldehydes and ketones. Structure, nomenclature, examples. Physical properties. Methods of preparation. Chemical properties. The general mechanism of nucleophilic addition reactions. Nucleophilic addition reactions. Reduction, oxidation and oxido-reduction reactions. Methods of analysis
28. Carboxylic acids. Structure, nomenclature, examples. Physical properties. Industrial sources and methods of preparation. Chemical properties. Methods of analysis
29. Functional derivatives of carboxylic acids. Structure, classification, physical properties. General mechanism of nucleophilic substitution. Reactions of the functional carboxylic acid derivatives series
30. Acid chlorides: Nomenclature. Methods of preparation. Chemical properties.
31. Acid Anhydrides: Nomenclature. Methods of preparation. Chemical properties
32. Amide: Nomenclature. Methods of preparation. Chemical properties

33. Esters. Nomenclature. Processing methods. Chemical properties. Reactions of esters that flow through carbanions. Claisen Condensation. Reformatsky's reaction. Synthesis of carboxylic acids from malonic acid ester. Synthesis of ketones from acetoacetic ester. Decarboxylation of β -ketonic acids. Methods of analysis of functional derivatives of carboxylic acids
34. Functional derivatives of carbonic acid. urea, phosgene, carbonates and carbamates, isocyanates, urethanes and polyurethanes, cyanamide. Methods of preparation and properties
35. Amine: Nomenclature. Methods of preparation. Physical and chemical properties. Methods of analysis
36. Heterocyclic Compounds
37. Lipids. Fats and Steroids
38. Carbohydrates
39. Amino Acids and Proteins

REFERENCES

1. Michael B. Smith, Jerry March, March's advanced organic chemistry, reactions, mechanisms and structure, sixth edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2007.
2. Morrison, R.T., Boyd, R.N., Organic Chemistry, 7th ed. pdf.
3. Solomons, T.W.G., Fryhle, C.B., Organic Chemistry, 8th ed., John Wiley & Sons, Inc., 2004.

Professor,

Prof. PhD. Eng. Ion Bolocan

Responsible for the doctoral field,

Prof. habil. PhD. Eng. Diana Cursaru