UNIVERSITY OF GOTHENBURG

DEPARTMENT OF CHEMISTRY AND MOLECULAR BIOLOGY

KEM815 Advanced Organic Chemistry, 15 credits

Avancerad organisk kemi, 15 högskolepoäng

Second Cycle

Confirmation

This course syllabus was confirmed by Department of Chemistry and Molecular Biology on 2013-07-05 and was last revised on 2017-08-25 to be valid from 2017-08-25, autumn semester of 2017.

Field of education: Science 100%
Department: Department of Chemistry and Molecular Biology

Position in the educational system

The course is classified at the level 90-120 credits for Degree of Bachelor and can be counted as a course at second cycle level for Degree of Master (120 credits). The course can be read as a freestanding course. This course replaces course KEM810 and part of course KEM820, the course may not be counted in together with any of courses KEM810 or KEM820 in a degree.

The course can be part of the following programmes: 1) Chemistry and learning, Master's Programme (N2KOL), 2) Master's Programme in Organic and Medicinal Chemistry (N2KEL), 3) Bachelor of Science Programme in Medicinal Chemistry (N1LMK), 4) Master's Programme in Chemistry (N2KEM) and 5) Bachelor of Science Programme in Chemistry (N1KEM)

Main field of studies	*Specialization*
Chemistry with Specialization in Medicinal Chemistry	A1N, Second cycle, has only first-cycle course/s as entry requirements
Chemistry	A1N, Second cycle, has only first-cycle course/s as entry requirements

Entry requirements

For admission to the course, completed and passed courses in the main field of study of chemistry worth 50 credits are required, including course KEM030 or KEM031, Organic Chemistry or an equivalent course worth 15 credits.

Learning outcomes

On completion of the course, the student should have such knowledge and experimental skills in organic chemistry that is required to be able to carry out plan and understand advanced organic synthesis as well as carry out qualified separation and structural analysis of organic compounds. The knowledge that is acquired are necessary for continued, higher studies in organic chemistry and medicinal chemistry.

Knowledge and understanding

- in depth **explain** reaction patterns and selectivity in typical bond-creating reactions,
- mechanistically **explain** the course of reactions for both elementary reactions and catalytic systems,
- **account for** classical synthesis methods and its usefulness in synthesis of complex molecules,
- **account for** stereochemical concepts and **explain** stereoselective reactions,
- **explain** the basics of retrosynthetic analysis and synthesis planning,
- **explain** how principles and experiments from physical organic chemistry can be used to understand reaction mechanisms and selectivity in typical synthetic processes,
- broadly **present** analytical methods for structure determination of organic compounds as well as how these methods can be used to study reactivity.

Competence and skills

- **implement** knowledge of the addition reactions of nucleophilic agents with carbonyl compounds, enolate/enol chemistry, condensation reactions, cross-coupling methodology, fragmentation and rearrangement reactions for the synthesis of complex compounds,
- **choose** and **utilise** adequate methods for separation of organic compounds in both analytical and preparative scale,
- **discuss** reaction mechanisms and different methods to distinguish between competing mechanisms,
- **plan** a synthesis by means of retrosynthetic analysis,
- **utilise** 1 and 2-dimensional NMR-spectroscopy for identification and structure determination,
- **apply** the relationship between physico-chemical properties and molecules of structure at study of chemical processes.

Judgement and approach

- critically **review** the literature and conclusions that have been presented there,
- **assess** their own level of knowledge on the subject,
- **assess** the strategic level on synthetic solutions to complex compounds,
- **handle** and **evaluate** relevant sustainability aspects in organic chemistry,
- **assess** and **prevent** security threats in connection with all activities that includes organic compounds.

Course content

The aim of the course is to give advanced and expanded knowledge and experimental skills in organic chemistry with a focus on synthetic aspects of complex organic compounds. The course is divided into a theoretical part and a practical part.

Sub-courses

1. **Theory** *(Teori),* 11 credits
   Grading scale: Pass with Distinction (VG), Pass (G) and Fail (U)
   - Nucleophilic addition reactions to carbonyl compounds
   - Enolate additions to alkyl halides and carbonyl-containing compounds as well as condensation reactions
   - Acid-base properties, equilibrium and organic-chemical mechanisms
   - Relationship between chemical structure and chromatographic properties
   - Stereochemistry, stereoselectivity and stereospecificity
   - Asymmetric synthesis and catalysis
   - Different principles of resolving of the racemate (kinetically and thermodynamically based)
   - Synthesis planning and retrosynthetic analysis
   - Rearrangement reactions and fragmentations
   - Methods to analyse reaction mechanisms
   - Physico-chemical properties of bioactive organic molecules
   - Advanced and expanded treatment of structural analysis by means of spectroscopic methods (NMR, IR, UV) as well as mass spectrometry (MS). Particular emphasis is put on: One- and multidimensional pulse and Fourier transform NMR Spectroscopy and its use for molecular structure analysis, mainly by means of chemical shifts, coupling constants, nuclear Overhauser effects and line shape analysis, as well as the use of different ionisation techniques in mass spectrometry for identification and structure determination of organic compounds by means of molecular weight determination and fragmenting patterns. Methods for stereochemical correlation.

2. **Laboratory Work and Exercises** *(Laborationer och gruppövningar),* 4 credits
   Grading scale: Pass (G) and Fail (U)
   The laboratory sessions consist of an and multistep syntheses that should illustrate

the theoretically treated components. Strong emphasis is placed on isolation and purity determination. In group work, different target molecules are analysed retrosynthetically and alternative synthetic routes be discussed.

Form of teaching

Module 1: The teaching includes lectures and exercises.

Module 2: The teaching includes an introductory lecture, a safety lecture with written test, group work and laboratory sessions. All these components are compulsory. Passed result on the safety test is required for participation in the laboratory sessions.

Language of instruction: English and Swedish
As principal rule, the course is given in Swedish but it can be given completely or partly in English if the circumstances require it.

Assessment

Module 1: Examination takes place through written examination at the end of the course and several written diagnostic tests that are organised as per schedule continuously during the course.

Module 2: Examination takes place continuously through reports and presentations during the course.

For students who have not passed the regular examination, additional examination sessions are offered. If a student who has has failed twice on the same assessing component wishes to change of examiner before the next examination session such request should be submitted in writing to the department and be approved if there are not special causes against it.

Grades

The grading scale comprises: Pass with Distinction (VG), Pass (G) and Fail (U).
Module 1: The grade is based on the diagnostic tests as well as the examination.

Module 2: The grade is based on reports and presentations.

Final grade:
For grade of Pass on the whole course, grades of Pass on both modules are required.

For grade of Pass with distinction on the whole course, grade of Pass with distinction on module 1 and grade Pass on module 2 are required.

Regarding application of the ECTS scale for grade please see vice chancellor's decision 28/05/2007, diary nr G 8 1976/07.

Course evaluation

A course evaluation is done in relation to the expected learning outcomes and contents of the course and is carried out at the end of the course through an individual written questionnaire on University of Gothenburg's virtual learning environment. A student who participates in or has completed a course should be given the opportunity to anonymously express experiences of and views on the course in a course evaluation. A compilation of the course evaluation and course coordinator's reflection should be made available for the students within reasonable time after the end of the course.