

Synthetic Methods and Strategies (C004137)

Course size *(nominal values; actual values may depend on programme)*

Credits 4.0 **Study time 105 h**

Course offerings and teaching methods in academic year 2025-2026

A (semester 2) English Gent independent work
lecture

Lecturers in academic year 2025-2026

Winne, Johan WE07 lecturer-in-charge
Kydonakis, Marios WE07 co-lecturer

Offered in the following programmes in 2025-2026

| | crdts | offering |
|---|-------|----------|
| Master of Science in Teaching in Science and Technology(main subject Chemistry) | 4 | A |
| Master of Science in Chemistry(main subject (Bio)Organic and Polymer Chemistry) | 4 | A |
| Exchange Programme in Chemistry (master's level) | 4 | A |

Teaching languages

English

Keywords

Total Synthesis, strategic bond forming reactions, synthetic planning, C-H activation logic in synthesis, multistep synthesis, electrocatalytic methods, photoredox catalysed methods, synthesis design, synthesis evaluation, economic value of synthesis, free radical cross-coupling methods

Position of the course

This course unit is an elective course in the master degree.
The course intends to provide students insight into different methods used in the conception of a synthesis plan, including the use of modern free radical cross-couplings, including C-H activation methods, electrochemical methods, photoredox catalysed and electrocatalytic synthetic transformations.
The following competences related to the master degree are relevant: M.2.4, M.2.5, M.3.1, M.3.4.

Contents

The course deals with these themes:
-Strategy and economy in synthesis design
Convergent total synthesis; Retrosynthesis; Transform-oriented synthesis; Reconnective synthesis; Multiple bond forming steps; Using scientific literature in synthesis design (scifinder);
-Modern powerful bond forming reactions:
Cross coupling reactions, principle of C-H activation logic, fundamental principles and practical applications of electrochemical reactions and electrocatalysis, modern free radical cross-couplings that complement classical transition metal catalysed ones, photoredox catalysis in synthesis, critical review of contemporary literature on synthetic methodology
-examples of industrial scale complex multistep total syntheses
-examples of highly efficient academic complex total syntheses

Initial competences

To have insight into the concepts that determine the structure and reactivity of organic molecules. To know the current synthetic methods, including transition metal mediated cross-couplings (Suzuki, Negishi, Heck, Buchwald, ...), and to be

able to solve simple synthetic problems. To have successfully followed the Master courses "Advanced Organic Chemistry".

Final competences

- 1 To explain and illustrate important concepts of synthetic planning using an example.
- 2 To analyse and evaluate the strategic-economic merit of synthetic pathways.
- 3 To identify key steps in a synthetic sequence.
- 4 To solve synthetic problems using scientific literature resources.
- 5 To analyse complex synthetic problems and independently suggest an appropriate synthetic method or strategy as potential solutions.
- 6 To conceive a synthetic pathway for a simple target molecule.
- 7 To be familiar with the most recent techniques in synthesis and to have a thorough insight in the methods and principles of organic electrochemistry and photoredox chemistry.
- 8 To have a thorough insight in the underlying mechanisms of modern free radical based cross couplings and related synthetic transformation and to be able to implement them in synthetic applications.
- 9 To be able to understand and follow new developments in the field via the literature.

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Seminar, Lecture, Independent work

Extra information on the teaching methods

For the 'synthesis strategy' course part, students receive an individual assignment in which a synthetic plan should be suggested for a somewhat complex target molecule. Each student is assigned a different molecule, or can make a suggestion (for instance, after consulting with a master thesis promotor). Students are expected to use all available sources of information (books, research papers, internet search engines,...) to arrive at a viable and well-conceived synthetic plan. The suggested synthetic route will be discussed as part of the oral examination, and will form the basis of the questioning for an important part of the exam. The part of the course on synthetic methods is taught via lectures and seminars. Partial course credit (15%) will be associated to an individual assignment in which the student is asked to read, critically analyse and present the main findings of a recent paper on modern synthetic methodology.

Study material

Type: Syllabus

Name: synthesis strategy
Indicative price: Free or paid by faculty
Optional: no
Language : English
Number of Pages : 140
Available on Ufora : Yes

Type: Slides

Name: lecture slides organometallics
Indicative price: Free or paid by faculty
Optional: no
Language : English
Number of Slides : 200
Available on Ufora : Yes

Type: Slides

Name: lecture slides synthesis strategy
Indicative price: Free or paid by faculty
Optional: yes
Language : English

References

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Course content-related study coaching

Oral explanation after electronic contact. Tutorial session about the individual assignment.

Assessment moments

end-of-term and continuous assessment

Examination methods in case of periodic assessment during the first examination period

Oral assessment, Written assessment with open-ended questions

Examination methods in case of periodic assessment during the second examination period

Oral assessment, Written assessment with open-ended questions, Presentation

Examination methods in case of permanent assessment

Possibilities of retake in case of permanent assessment

not applicable

Extra information on the examination methods

The part on "Synthetic Methods" and the part on "Synthesis Strategy" are evaluated separately via classical written exams (with oral justification of answers) on a different day.

The individual assignment for the synthesis strategy partim (complex synthesis plan) can be regarded as an exam question for which students have been given the opportunity to have more time and resources than would be possible in a normal exam. This includes two guiding works shops, one for 'project kick off' and another for intermediate feedback on project progress. Students are expected to bring their final work along to the exam and discuss it during the oral examination. Evaluation happens during the oral exam, and the whole exam set-up is based on the individually chosen target molecule and its synthesis.

The individual assignment for the synthetic methods partim (presentation of research paper from recent literature) happens during a seminar where students will present the main findings and have to critically reflect on questions by the teachers and fellow students. This presentation will be organized (and evaluated) at the end of the semester during the normal course weeks, and will amount to 15% of total credit for the course.

For the written exam on the synthesis strategy partim, individual use of any non-digital source of information is allowed (books, syllabi, lecture notes, ...). This is not the case for the written exam for the partim synthetic methods, which is a classical exam. Examples of typical exam questions will be made available to students.

Calculation of the examination mark

Partim Synthesis strategy: **50%** (The oral examination concerning the individual assignment contributes 25% of the total mark, the written exam constitutes of designing a total synthesis for a target related to your chosen compound and contributes another 25%).

Partim Synthetic Methods: **50%** (35% for the written exam + 15% for presentation (individual assignment)).