

CHEM-E1130 Catalysis

Course introduction



Aalto University
School of Chemical
Engineering

Prof. Riikka Puurunen

14.1.2018

In this course, you will learn...

... to speak the language of catalysis

(and other things, too)

Learning outcomes (modified)

After the course the students are able to:

1. **give the definition of catalysis** and **describe concepts** related to heterogeneous and homogeneous catalysts
2. **explain** steps and methods in **catalyst preparation**
3. **describe and apply** selected **catalyst characterization** methods
4. **explain** why and how **catalysts deactivate** and how catalyst deactivation can be postponed or prevented
5. **give examples** of **where catalysts are applied**
6. **recognize challenges** potentially solvable by catalytic reactions

Note, Prof. Puurunen, 7.1.2019: These learning outcomes have not yet been accepted for the course. Students are welcome to comment on these proposed learning outcomes. We will in practice follow these in the course in 2018-2019

As in [Oodi](#) (2018-2020). We will fulfill these learning outcomes in 2018-2019, too, although we will already follow the proposed updated learning outcomes.

After the course the students

1. know the basic principles of catalysts and catalysis
2. understand the concepts of heterogeneous and homogeneous catalysis
3. describe how catalysts can be prepared, characterized and used
4. define the challenges related to catalytic reactions
5. identify different stages in catalytic reactions (mass transfer and surface reactions)
6. understand how catalysts deactivate
7. are familiar with applications of catalysis

CHEM-A1110, Virtaukset ja reaktorit

CHEM-C2120 Industrial
Processes in Bio and Chemical
Technology

CHEM-E7150
Reaction
Engineering

CHEM-E7135
Reactor Design

**CHEM-E1130
Catalysis**

CHEM-E1140
Catalysis for Biomass
refining

CHEM-E7115 Experimental Assignments in Chemical
Engineering

CHEM-E8105 Enzymatic and
Biomimetic Catalysis

Course in a larger Aalto framework

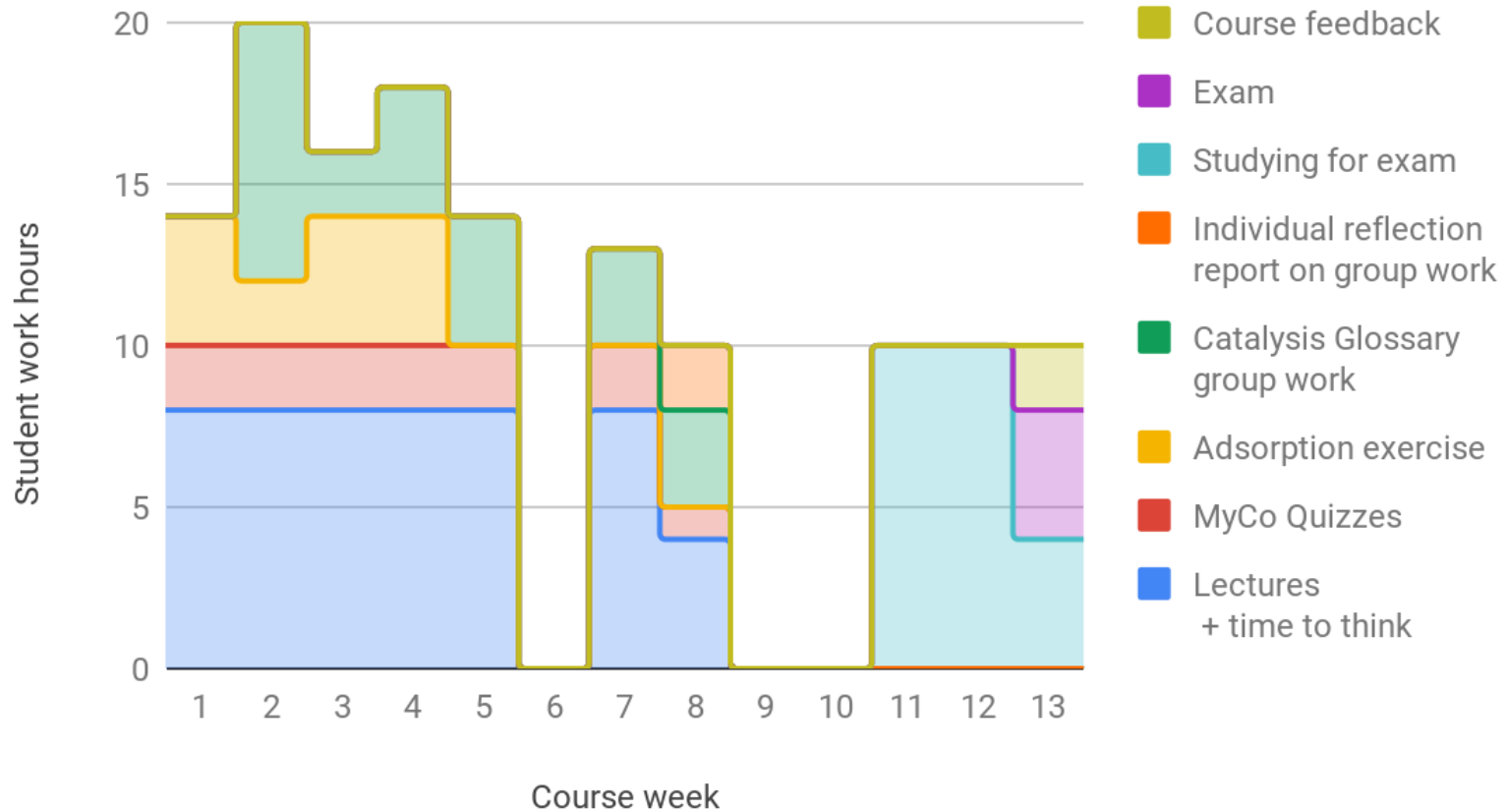
- + Inorganic chemistry
- + Organic chemistry
- + Polymer chemistry
- + Surface physics
- + ...

Workload & evaluation

5 ECTS. 60 pt to pass, 100 pt max

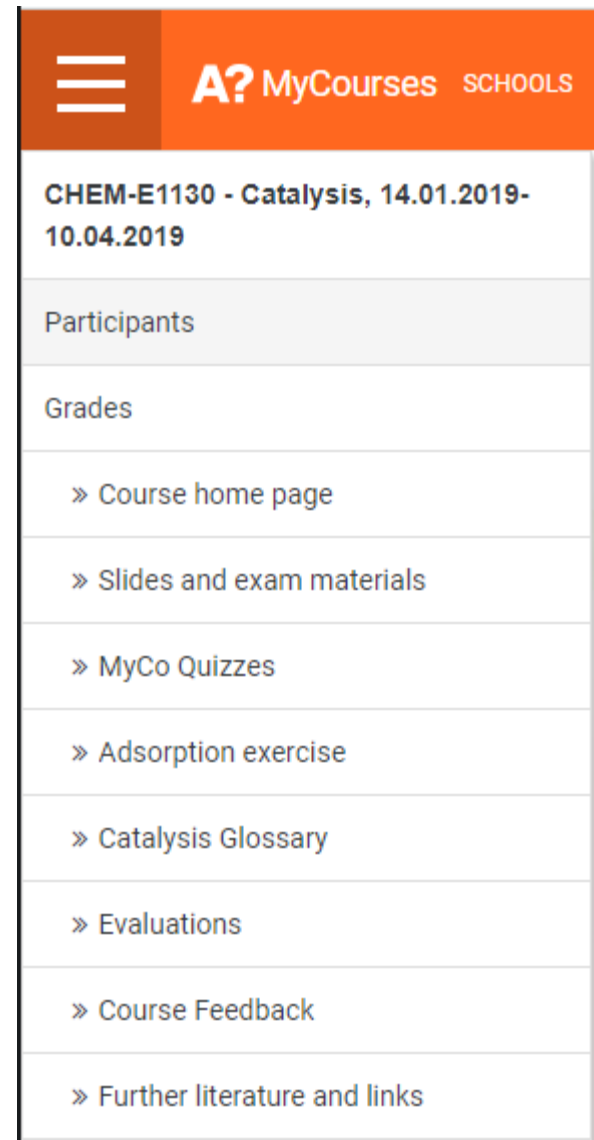
Activity	Time allocation	Max points
Lectures + time to think	13 x 2 h = 26 h +13 x 2 h = 26 h	-
MyCo Quizzes	13 x 1 h = 13 h	20
Adsorption exercise	2 + 12 h = 14 h	12
Catalysis Glossary as group work	24 h	18
Individual reflection report on group work	2 h	3
Studying for exam	24 h	-
Exam	4 h	45
Course feedback	2 h	2
Total	135 h	100

CHEM-E1130 Catalysis: Expected workload 2018-2019



Lectures: Mon & Wed at 14:15

- Goal: lecture capture with Panopto
- Lecture slides shared after lecture
- **Lecture slides will serve as exam material**
- Plan: Towards the end of the course, a document will be shared with outline of all lecture contents (will help in studying for exam)




The screenshot shows the MyCourses interface for the course CHEM-E1130 - Catalysis, 14.01.2019-10.04.2019. The interface is displayed in a vertical list format with an orange header bar. The header bar contains a hamburger menu icon, the text 'A? MyCourses', and 'SCHOOLS'. Below the header, the course title and dates are displayed. The main content area is a list of links, each preceded by a right-pointing chevron symbol. The links are: Participants, Grades, Course home page, Slides and exam materials, MyCo Quizzes, Adsorption exercise, Catalysis Glossary, Evaluations, Course Feedback, and Further literature and links.

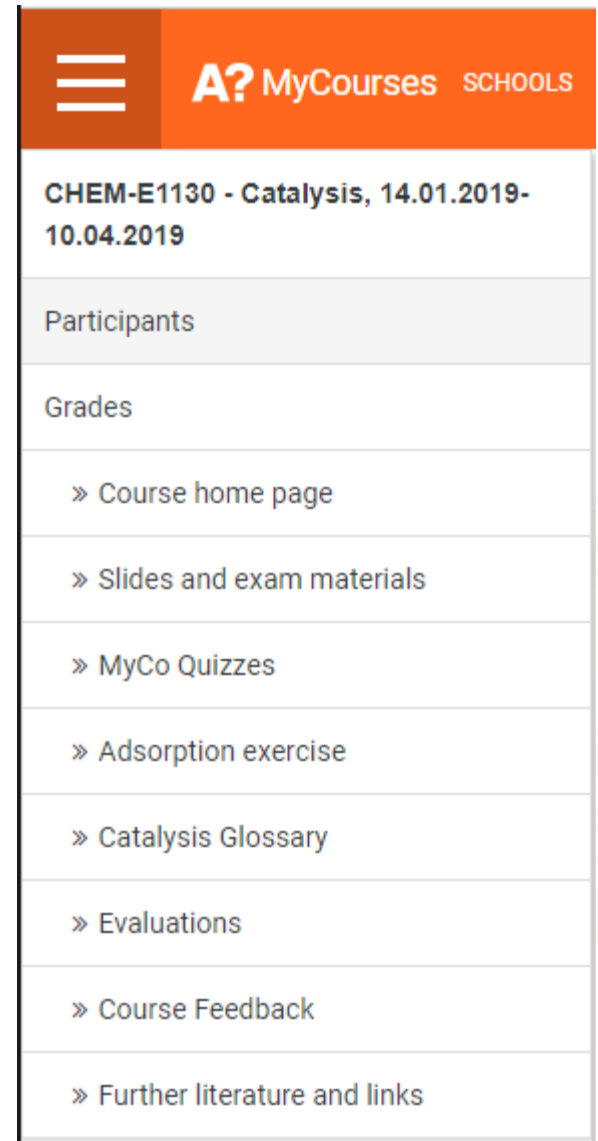
A? MyCourses SCHOOLS	
CHEM-E1130 - Catalysis, 14.01.2019-10.04.2019	
Participants	
Grades	
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Lecture plan

	Teacher	Contents
L1	Prof. Riikka Puurunen	CHEM-E1130 Catalysis course introduction & Introduction to catalysis
L2	Prof. Riikka Puurunen	Industrial catalysis: significant historical examples
L3	Prof. Riikka Puurunen	Catalyst characterization 1: Adsorption methods
L4	Prof. Riikka Puurunen	Preparation of heterogeneous catalysts
-	M.Sc. Eveliina Mäkelä	assistant hour, adsorption exercise
L5	Dr. Reetta Kaila	Case: catalysis and renewable fuels in marine industry
L6	Prof. Riikka Puurunen	Catalyst characterization 2: Physicochemical properties
-	-	<group work time and space reservation>
L7	Dr. Teuvo Maunula	Case: Catalysts in automotive applications <tentative title>
L8	Dr. Tiia Viinikainen	Catalyst characterization 3: Spectroscopic in situ/operando methods
L9	Prof. Jan Deska	Homogeneous catalysis
L10	Prof. Riikka Puurunen	Deactivation of heterogeneous catalysts
-	-	<group work time and space reservation>
L11	Prof. Riikka Puurunen	Adsorption-controlled preparation of catalysts by Atomic Layer Deposition
L12	Prof. Riikka Puurunen	Catalysis applications: future research directions
L13	Prof. Riikka Puurunen	CHEM-E1130 Catalysis course: Wrap-up
		<reserve slot>

MyCo Quizzes after each lecture

- Quiz opens after each lecture & is open for 3 working days (closes at 23:55)
- Max 2 points per quiz, best ten quiz results are counted
- Quizzes are **developing**: Automated correction, correct answers shared after quiz is closed, synchronized with lectures 
- Separate reminder will NOT be sent of the quiz after each lecture (1st lecture exception)
- Assistant: M. Sc. Jose Luiz Gonzalez Escobedo



A? MyCourses SCHOOLS

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Adsorption exercise (Renewed)

- The same exercise for all students, with unique combination of real physisorption and chemisorption data
- 16.1. Adsorption characterization exercise shared
- 25.1. Assistant hour, adsorption exercise, 12-14 A302 Ke3
- DL: 8.2.
- Assistant: M.Sc. Eveliina Mäkelä



MyCourses SCHOOLS

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Catalysis Glossary as group work – **New!**

- The course participants will jointly create **Catalysis Glossary** with field-specific terms and with explanations.
- The generated document will be material for examination
- Work in three parts: (i) terminology, (ii) descriptions, (iii) check the result.
- Groups to be formed on 21.1.
- DL for final work: 27.2.
- Assistant: M.Sc. Minna Marin



☰ A? MyCourses SCHOOLS

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Catalysis Glossary 1st edition: to be further used & developed

- **CHEM-E1130 2018-2019: 1st version → exam material**
- **After the course?**
 - Aimed to use as reference material in CHEM-E1140 2018-2019
 - Likely to be used as reference and/or exam material in CHEM-E1130, CHEM-E1140 and optionally in other courses
 - May be further built upon → 2nd edition, 3rd edition, etc
- **Aim is that the names of all contributors will be acknowledged. By default, if not otherwise agreed, everyone's name who participated in the Catalysis Glossary will be included.**

Evaluations

- **When points are earned in the course, we will update the info in an own MyCo page**
- **(technical details yet to be decided)**



The screenshot shows the MyCourses interface for a course. At the top, there is an orange header with a hamburger menu icon, the text 'A? MyCourses', and 'SCHOOLS'. Below the header, the course title 'CHEM-E1130 - Catalysis, 14.01.2019-10.04.2019' is displayed. The main content area is a list of links, each preceded by a right-pointing chevron. The links are: 'Participants', 'Grades', '» Course home page', '» Slides and exam materials', '» MyCo Quizzes', '» Adsorption exercise', '» Catalysis Glossary', '» Evaluations', '» Course Feedback', and '» Further literature and links'. The 'Evaluations' link is highlighted with a green arrow pointing to it from the left.

Feedback

- All feedback is appreciated
- **Anonymous course feedback (Webropol) at the end → 2 points**
- You can give feedback after each lecture in MyCourses
- Individual reflection report on group work → 3 points
- Last year's feedback in Course Feedback, too



A? MyCourses SCHOOLS

CHEM-E1130 - Catalysis, 14.01.2019-10.04.2019

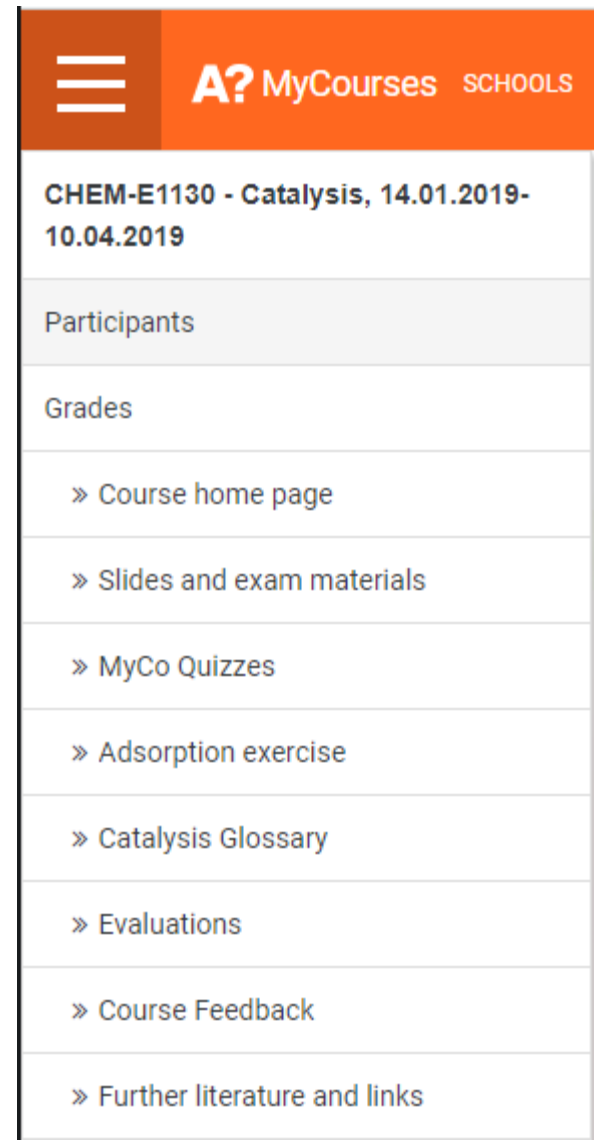
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Further literature and links

- Here will be links to electronic materials available within Aalto University which are useful related to learning Catalysis and Industrial Chemistry
- You can use these materials e.g. when finding explanations for Catalysis Glossary
- For clarity: these materials will NOT be exam materials



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Course renewal in 2018-2019

- **Shorter course: two lectures per week**
- **Lecture order & contents developed. Characterization 1-2-3.**
- **1st trial for separately recorded teaching video**
- **MyCourses Quizzes**
 - Share answers shown after quiz is closed. Voluntary possibility for giving feedback after each lecture
- **Adsorption exercise organization & grading**
 - Dual returning no longer applied
 - Opportunity to ask feedback in advance in a guided session
- **Group work → Catalysis Vocabulary co-creation**
 - Time slots organized in advance for group work

Catalysis course "crew" 2019

Catalysis group webpage: <http://aalto.fi/cmet/catalysis>

Find us in aalto.fi

Follow us: Twitter [@aaltocatalysis](https://twitter.com/aaltocatalysis) [@rpuu](https://twitter.com/rpuu), Instagram: [aaltocatalysis](https://www.instagram.com/aaltocatalysis)

Catalysis Professor's Open blog: <https://blogs.aalto.fi/catprofopen/>



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Bonus slide:

- **Course renewal in academic year 2017-2018**
- **Doctoral theses of the lecturers**

CHEM-E1130 course renewal in academic year 2017-2018

Course renewal in 2017-2018

- Lectures: one main responsible + visitors
- Group works: videos as outcome **NEW** + short report
- Calculation exercise (adsorption characterization) **NEW**
- Panopto lecture capture **NEW**
- Presemo activation & feedback during lecture **NEW**
- Course evaluation renewed → 100 pt **NEW**

- Course is Puurunen's development target in pedagogical training → student feedback during (Presemo, MyCo) **NEW** & after

Course feedback 2017-2018

Course: CHEM-E1130 Catalysis	2017-2018	2016-2017
Students enrolled in course (from OODI)	32*	49
Students giving feedback (target 2018 was: 80%)	27 (84%)	12 (24%)
Students taking the course exam	29 (91%)	30 (61%)
My overall assessment of the course (average)	4.04	2.6
The teaching methods (lectures, labs, group work, online study, assignments etc.) supported my learning (average)	3.96	2.7
How was your study motivation affected by the course? (average)	3.88	2.8
The course enhanced my general skills (average)	3.89	2.2

Student feedback Panopto CHEM-E1130+CHEM-E1140

- Generally, really good. I enjoyed them. If something wasn't clear from the lecture notes, then you could just jump back to the lecture and listen it over again.
- GREAT! AWESOME! WELL DONE!
- It is a very good option to be able to go through the lectures at your own time in your own peace afterwards.
- Some students need more repetition than others.
- It is good to have videos of lectures if you are not able to participate.
- Panopto recordings were usefull to get supplementary info that I missed during the lecture.
- Using Panopto to caprure lectures is a great thing, especially for people that cannot attend every lecture. It also worked well with the lecture excercises (listening to the lecture gave more info than just reading slides).
- ... the panopto recording is a lifesaver for a students who start working before may.
- Lectures were interesting and it was nice that there was usually time to ask questions. Filming the lectures was good, and it should be used in other courses as well.
- The “on-line format” of the course was excellent, with all the available recorded classes. I hope we can have more courses like this, I think you are reaching the future with this type of teaching process. (Individual reflection report, CHEM-E1140)

**Doctoral theses of the lecturers –
all from Aalto University /
Helsinki University of Technology**

Prof. Riikka Puurunen, 2002

2002	Riikka Puurunen	Preparation by Atomic Layer Deposition and Characterisation of Catalyst Supports Surfaced with Aluminium Nitride	https://aaltodoc.aalto.fi/handle/123456789/222 5
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Dr. Teuvo Maunula, 2007

2007	Teuvo Maunula	Nox reduction by hydrocarbons and hydrogen on metal oxide and zeolite based catalysts in lean conditions	https://aaltodoc.aalto.fi/handle/123456789/2908
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Dr. Reetta Kaila, 2008

2008	Reetta Kaila	Autothermal reforming of simulated and commercial fuels on zirconia-supported mono- and bimetallic noble metal catalysts	https://aaltodoc.aalto.fi/handle/123456789/4539
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Dr. Tiia Viinikainen, 2017

2017	Tiia Viinikainen	Characterization of zirconia-based gasification gas clean-up catalysts	https://aaltodoc.aalto.fi/handle/123456789/25178
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