SYLLABUS

A. Course Description

Course Code	*Course Num.*	*Course Name*	*Credit Hours*	*Lec.*	*Lab.*	*Tut.*	*Private study*	*Pre-requisites*	*Course Level*	*Language*
CHM	**447**	**Homogeneous and Heterogeneous Catalysis**	**2**	**2**	**0**	**0**	**4**	**CHM 345**	**7**	**English**

This course describes the definitions and types of homogeneous and heterogeneous catalysts, extending to the preparation methods and characterization. This course is designed to provide with the concepts of heterogeneous catalysis, theoretical, methodological and technical knowledge of the catalysts and catalytic cycle. The course will cover solution chemistry, organometallic chemistry and physical chemistry in the point of catalysis view.

At the end of this course the student will be able to:

- list the main concepts and applications of homogeneous and heterogeneous catalysis.
- outline the concept of acid-base catalysis and proton transfer.
- describe the acid-base cycle and its industrial application.
- recall the role of organometallics and metallic complexes in catalysis.
- estimate the kinetics and thermodynamic parameters of catalytic reactions.
- evaluate the rate constant of a chemical reaction.

B. References: Required Textbook & Internal Website

I shall use

Catalysis: Principles and Applications, B. Viswanathan, (1st Ed), Narosa, 2002, ISBN-10: 0849324246.

Students are required to purchase the textbook/materials (it is an obligation). The book contains the lecture notes as well as activities for the students to take part in; the book serves as a workbook. Other references:

- ***Catalytic Kinetics*,** Dmitry Yu Murzin, Tapio Salmi, (1st Ed), Elsevier, 2005, ISBN: 0080455468, 9780080455464.
- ***Homogeneous Catalysts: Activity - Stability - Deactivation*,** John C. Chadwick, Rob Duchateau, Zoraida Freixa, Piet W. N. M. van Leeuwen, Wiley, 2011, ISBN: 978-3-527-32329-6
- ***Heterogeneous Catalysis: Fundamentals and Applications,*** J. R. H. Ross Elsevier, 2012, ISBN: 978-0-444-53363-0.

Google Classroom Webpage: http://www.imamm.org/

C. Topics Outline

Disclaimer: this is a very fast-paced course. There will be little time—if any—for review. What follows is an approximate outline of the pace of the course. We may go faster or slower, contingent on the class response. The tentative list of topics to cover:

1. **Introduction to catalysis**: Fundamental Concepts of Homogeneous catalysis, Fundamental Concepts of Heterogeneous catalysis, advantages and disadvantages, Theoretical bases: Theories of acid-base, Acid-base equilibrium and acidity function.
2. **Kinetics of proton transfer reactions**: Theory quantum chemistry proton transfer, Theory of the acid-base catalysis the reaction intermediates, Reactions catalyzed by acids and bases, Esterification and hydrolysis of esters, Hydrolysis of amides and acids, Acid catalysis and its industrial applications, Main industrial catalysts, Catalytic cracking, Isomerization of light alkanes**.**
3. **Transition elements**: Introduction**,** Definitions, Coordination complexes, Stereochemistry of the transition metal complex, Reactions of transition metal complexes, Notion of catalytic cycle and different types of initiation complex, Tolman rule (16-18 electrons), fundamental reactions of complex, Industrial examples Hydrogenation, asymmetric catalysis, hydrocyanation, Hydroformylation, carbonylation, relationship, Oligomerization and polymerization of olefins , Oxidation reactions**.**
4. **Concepts of heterogeneous catalysis**: Introduction and Definition History , catalysts and catalytic properties, general mechanism of action catalyst, Heterogeneous catalysis Area of application: reactions and catalytic processes , catalytic converter, general mechanisms: diffusion, adsorption - desorption kinetics
5. **Catalysts:** Classification, synthesis, physicochemical characterization, activation, Notions of adsorption-desorption, Chemisorption and physisorption: Langmuir adsorption isotherm, Langmuir assumptions, Molecular adsorption of a compound, Dissociative adsorption of a compound. Adsorption of several compounds. Other chemisorption isotherm, Physical adsorption isotherm. Different type of isotherm. BET adsorption isotherm.
6. **Catalytic Cycle**: Irreversible unimolecular reaction. Irreversible bimolecular reaction, Mechanism of Langmuir- Hinshelwood: competitive adsorption and non-competitive. Adsorption mechanism Eley - Rideal

D. Exams & Grading System

The semi-official dates of the exams for this course, with all the caveats, that the word "semi-official" entails, can be found here:

- **Midterm 1:** 6th or 7th week &**Midterm 2:**11th or 12th week
- **Quizzes**: **2 Quizzes**
- **Homework: 4 Homework**
- **Final Exam:** 16th weak

- Your course grade will be based on Final Exam, Midterms, Homework, Quizzes, Participation, Attendance and Project.

Midterm 1: 20 %	**Midterm 2:** 20 %	**Final Exam:** 40 %
Quizzes; Homework & Attendance & Participation:20 %		

	Teaching/learning activities	Contact Hours	Frequency	Total Contact hours	Self-study hours (hrs)	Total self-study hours	Student Learning Time
1	Lecture	2	15	30	2	30	60
2	Tutorial	0	0	0	0	0	0
3	Lab\Practical	0	0	0	0	0	0
4	Lab report	0	0	0	0	0	0
5	Lab Exam	0	0	0	0	0	0
6	Homework	0	4	0	2	8	8
7	Quiz	0.25	2	0.5	1	2	2.5
8	Test (Midterm)	1.5	2	3	8	8	11
9	Final Exam	2	1	2	9	9	11
Total				35.5		57	92.5

– **Independent self-study = 57 /15 ≅ 4 hrs per week (**as average**)**

Grading distribution:

A^+: [95, 100], A:[90, 95), B^+: [85, 90) , B: [80, 85), C^+: [75, 80), C: [70, 75), D^+: [65, 70), D: [60, 65), F: [0, 60).

E. Student Attendance/Absence

Only three situations will be considered as possible excused absences:

- Occurrence of a birth or death in the immediate family will be excused. ("Immediate family" is defined by the University as spouse, grandparents, parents, brother, or sister).
- Severe illness in which a student is under the care of a doctor and physically unable to attend class will be excused. Students are not excused for a doctor's appointment. Do not make appointments that conflict with rehearsals. Notes from the University Health Center will be accepted.

Executive Rules for Study Regulations and Examsgoo.gl/ykm7t3

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