

COURSE OUTLINE

(1) GENERAL

SCHOOL	School of Sciences		
DEPARTMENT	Department of Chemistry		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	YN601	SEMESTER	6
COURSE TITLE	Industrial Catalysis		
TEACHING ACTIVITIES <i>If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.</i>	TEACHING HOURS PER WEEK	ECTS CREDITS	
-	6	5	
<i>Please, add lines if necessary. Teaching methods and organization of the course are described in section 4.</i>	-	-	
COURSE TYPE <i>Background, General Knowledge, Scientific Area, Skill Development</i>	Background		
PREREQUISITES:	No		
TEACHING & EXAMINATION LANGUAGE:	Greek		
COURSE OFFERED TO ERASMUS STUDENTS:	Yes		
COURSE URL:	https://chem.duth.gr/en/courses/industrial-catalysis		

(2) LEARNING OUTCOMES

Learning Outcomes <i>Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.</i>
<p>After the successful completion of the course, participants will be able to:</p> <ul style="list-style-type: none"> • Demonstrate advanced knowledge in the field of catalysis. • Possess advanced cognitive and practical skills for solving complex and unpredictable problems in applied catalysis at an industrial scale. • Manage complex techniques and methodologies to support decision-making in highly demanding industrial environments. <p>Knowledge</p> <ul style="list-style-type: none"> • Identify the different types and branches of catalysis. • Understand the fundamental principles and theories governing catalytic reactions. • Describe the main mechanisms of catalytic reactions. • Comprehend the kinetics and chemical engineering aspects of well-established catalytic reactions. <p>Skills</p> <ul style="list-style-type: none"> • Apply advanced methodologies to evaluate catalyst activity, selectivity, and stability.

- Analyze and classify catalysts based on physicochemical properties and performance criteria.
- Operate and integrate specialized laboratory and analytical equipment for catalytic studies.
- Process, evaluate, and interpret experimental data from catalytic reactions, including intermediate and final stages.
- Design and propose catalytic cycles and reaction pathways based on experimental and computational data.
- Perform techno-economic analyses for the industrial implementation of catalytic processes.
- Monitor and control catalytic processes using real-time data and automated control systems.

Abilities

- Make informed decisions in complex and unpredictable industrial catalytic systems affecting production processes.
- Select and justify appropriate analytical techniques, instrumentation, and methodologies based on efficiency and cost-effectiveness.
- Manage and supervise industrial catalytic processes and units within control room environments.
- Collaborate effectively in interdisciplinary and international teams to solve complex engineering and catalysis-related challenges.
- Integrate knowledge and skills to develop innovative solutions for industrial catalytic applications.

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,

ICT Use

Adaptation to new situations

Decision making

Autonomous work

Teamwork

Working in an international environment

Working in an interdisciplinary environment

Production of new research ideas

Project design and management

Equity and Inclusion

Respect for the natural environment

Sustainability

Demonstration of social, professional and moral responsibility and sensitivity to gender issues

Critical thinking

Promoting free, creative and inductive reasoning

The general skills that participants will have acquired upon successful completion of the module are:

- Search, analysis and synthesis of data and information, ICT use
- Adaptation to new situations
- Decision making
- Autonomous work
- Teamwork
- Working in an international environment
- Working in an interdisciplinary environment
- Production of new research ideas
- Project design and management
- Respect for the natural environment
- Sustainability
- Critical thinking

- Promoting free, creative and inductive reasoning

(3) COURSE CONTENT

THEORY

- Introduction to Catalysis
- Chemical Reaction Kinetics
- Heterogeneous Catalysis
- Homogeneous Catalysis
- Enzymatic Catalysis
- Heterogenized Homogeneous Catalysis
- Environmental Catalysis
- Catalytic Process Engineering
- Applications of Industrial Catalysis

LABORATORY

- Industrial Design and Modeling of Catalytic Processes
- Mixing and Separation of Multiphase Systems
- Catalytic Oxidation of Phenol
- Modeling and Simulation of Continuous Stirred-Tank Reactors (CSTRs)
- Biomass Quality Control
- Catalytic Production of First-Generation Biofuels
- Catalytic Production of Second-Generation Biofuels
- Determination of Produced (Bio)fuel Properties According to EN Standards
- Determination of Produced (Bio)fuel Properties According to ASTM Standards
- Industrial Monitoring and Control of Catalytic Processes in a Control Room Environment

(4) LEARNING & TEACHING METHODS - EVALUATION

<p>TEACHING METHOD <i>Face to face, Distance learning, etc.</i></p>	Face to face															
<p>USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) <i>Use of ICT in Teaching, in Laboratory Education, in Communication with students</i></p>	<p>Use ICT in teaching, in laboratory education and in communication with students:</p> <ul style="list-style-type: none"> • Digital slides • Scientific simulators • Videos • MS Teams / eclass, webmail 															
<p>TEACHING ORGANIZATION <i>The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.</i> <i>The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards.</i></p>	<table border="1"> <thead> <tr> <th><i>Activity</i></th> <th><i>Workload/semester</i></th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>39</td> </tr> <tr> <td>Laboratory exercise</td> <td>39</td> </tr> <tr> <td>Final project</td> <td>30</td> </tr> <tr> <td>Interactive learning</td> <td>10</td> </tr> <tr> <td>Laboratory report writing</td> <td>7</td> </tr> <tr> <td>Bibliographic research and analysis</td> <td>25</td> </tr> </tbody> </table>	<i>Activity</i>	<i>Workload/semester</i>	Lectures	39	Laboratory exercise	39	Final project	30	Interactive learning	10	Laboratory report writing	7	Bibliographic research and analysis	25	
<i>Activity</i>	<i>Workload/semester</i>															
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Interactive learning	10															
Laboratory report writing	7															
Bibliographic research and analysis	25															

	Total	150
<p align="center">STUDENT EVALUATION</p> <p><i>Description of the evaluation process</i></p> <p><i>Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others</i></p> <p><i>Please indicate all relevant information about the course assessment and how students are informed</i></p>	<p>The assessment of students in the theoretical part of the course is conducted through a written assignment accompanied by a public presentation (30%) and a final written examination (70%). The final written examination includes multiple-choice questions, short-answer questions, critical thinking questions, matching exercises, true/false questions, and problem-solving tasks. The grade for the theoretical component accounts for 60% of the overall course grade.</p> <p>The final grade of the laboratory component accounts for 40% of the overall course grade and is calculated as follows:</p> <ol style="list-style-type: none"> 1. Pre-laboratory test (Pre-Lab Test): 15% (Grade E1) 2. Successful completion of the laboratory exercise, proper presentation and evaluation of experimental data, diligence, and active participation during the laboratory session: 35% (Grade E2) 3. Final written examination at the end of the semester: 50% (Grade E3) <p>Final Laboratory Grade: (E1×0.15)+(E2×0.35)+(E3×0.50)</p> <p>The language of assessment is Greek.</p> <p>The evaluation criteria are communicated from the beginning of the course and are accessible to students via eclass.</p>	

(5) SUGGESTED BIBLIOGRAPHY

- Recommended bibliography:

1. Ετερογενείς Καταλυτικές Αντιδράσεις και Αντιδραστήρες, Ξ. Βερούκιος, 1^η Έκδοση, 2004, ISBN: 978-960-87655-3-5.
2. Οργανομεταλλική-Καταλυτική Χημεία, Κ. Δημάδης, Α. Κοκολάκης, 2016, ISBN: 978-960-603-317-9.
3. Industrial Catalysis, J. Hagen, 2nd Edition, Wiley-VCH Verlag GmbH & Co. KGaA, 2006, ISBN: 978-3-527-31144-6.
4. Industrial Catalysis, R. I. Wijngaarden, K. R. Westerterp and A. Kronberg, Wiley-VCH Verlag GmbH & Co. KGaA, 1998, ISBN: 3-527-28581-4.
5. Aqueous-Phase Organometallic Catalysis: Concepts and Applications, B. Cornils, W. A. Herrmann, Wiley-VCH Verlag GmbH & Co. KGaA, 2004, ISBN: 3-527-30712-5.
6. Aqueous Organometallic Catalysis, Ferenc Joó, Kluwer Academic Publishers, 2002, ISBN: 1-4020-0195-9.

- Relevant scientific journals:

1. Journal of Applied Catalysis, Elsevier.
2. Reaction Chemistry & Engineering (RSC)
3. Catalysis in Industry (Springer)
4. ChemCatChem (Wiley)