Course Specification

(Postgraduate Programs)

Course Title:	Catalysis and its Industrial Applications
Course Code:	CHM 6144
Program:	Master of science in chemistry
Department:	Chemistry
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University
Version:	*Course Specification Version Number*
Last Revision Date:	*Pick Revision Date.*

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A. General information about the course:

1. Course Identification:

1. Credit hours: 3 (3 Lectures, 0 Lab, 0 Tutorials)

2. Course type

A.	☐University	☐College	☐Department	☐Track
B.	☐Required		☒ Elective	

3. Level/year at which this course is offered: Level 2/Year 1

4. Course General Description:

This course is designed in two parts. The first one will cover the fundamentals addressing the activity patterns, adsorption–desorption phenomena, and advanced theories. The second part will provide the conventional methods of characterizing properties; and methods of preparation with pre/post-treatment; the most important traits, with examples and practices; spectroscopic characterizations, even in situ; Nanostructured catalysts the micro kinetic chemistry and surface mechanisms, and finally the evaluation of an industrial catalyst process.

5. Pre-requirements for this course (if any):

Advanced Physical Chemistry – CHM 6141

6. Pre-requirements for this course (if any):

None

7. Course Main Objective(s):

- Improve their knowledge of the fundamentals and concepts of Homogeneous and Heterogeneous catalysis.
- Recognize the Homogeneously and Heterogeneously Catalyzed in industrial process .
- Develop their knowledge of Bio-catalysis, and Electro-catalysis.
- Be familiar with Planning, Development, and Testing of Catalysts.
- Outline Catalyst Shapes and Production of homogeneous and Heterogeneous Catalysts.

2. Teaching Mode: (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	45	100 %
2	E-learning		
3	Hybrid • Traditional classroom		

No	Mode of Instruction	Contact Hours	Percentage
	• E-learning		
4	Distance learning		

3. Contact Hours: (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	45
2.	**Laboratory/Studio**	0
3.	**Field**	0
4.	**Tutorial**	0
5.	**Others (specify)……**	0
	Total	45

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods:

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**To recall knowledge of Homogeneous and Heterogeneous Catalysis and its applications in Industrial Processes**	**K1. *Phy*.; K2. *Phy*.; K4. *Phy*.**	▪ Five hours/week lectures. ▪ Self-study Home-exam.	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion Participation.
1.2	**To state catalyst development, planning and, testing.**	**K1. *Phy*.; K3. *Phy*.**	▪ Five hours/week lectures. ▪ *Think* to justify Catalyst development, using available references (SDL) online. Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
1.3	**To describe the bio-catalysis and Electro-catalysis.**	**K1. *Phy.*; K3. *Phy.***	▪ Five hours/week lectures. *Group Discussion* using available references (SDL) online, with mini-reports.	▪ *Midterm.* ▪ *Assignments* ▪ Open Discussions. ▪ Literatures Survey ▪ Mini-seminar .
1.4	**To recognize on the catalysis Reactors and their development.**	**K3. *Phy.*; K4. *Phy.***	▪ Five hours/week lectures. *Open Discussion* on Catalysis reactors applications using available references (SDL) online.	▪ *Assignments* ▪ Open Discussions. ▪ Literatures Survey ▪ Mini-seminar. Participation.
2.0	**Skills**			
2.1	**To explain the concepts and principles of Homogeneous and Heterogeneous Catalysis in industry**	**S1. *Phy.***	▪ Lectures activity ▪ Self-study. Deep discussion on principles of homogeneous and heterogeneous catalysis.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation Mini -seminar.
2.2	**To compare Homogeneously and Heterogeneously Catalyzed Industrial Processes and Bio-catalysis.**	**S1. *Phy.*; S2. *Phy.*; S3. *Phy.***	▪ *Practice* some examples catalysts for mechanism optimization, achieving. ▪ Brainstorming. Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation Mini -seminar.
2.3	**To explain the individual steps in the Heterogeneous, and Homogenous Catalysis process and its mechanisms in catalytic reactions.**	**S1. *Phy.*; S2. *Phy.*; S3. *Phy.***	▪ Lectures ▪ Oral Discussions. ▪ Brainstorming. Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion. Participation.

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
2.4	**To operate communication to different categories of Catalysis, its applications and impact in KSA industrial sector accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.**	**S1. *Phy*.; S4. *Phy*.**	▪ Group Discussion and Assignments. ▪ Suggest several catalysts to compare and differentiate for reading, writing, and oral presentation in groups. Encourage students to use electronic mail to submit Home Exams and Assignments	▪ Oral Discussion. ▪ Quizzes, and Exams. ▪ Giving marks for Oral Discussion in Lectures. Marks given for Assignments.
3.0	**Values, autonomy, and responsibility**			
3.1	**To perform a scientific presentation, research, and work independently and integrate with a collaborated group, Using IT to acquire, analyze, and communicate information.**	**V1. *Phy*.**	▪ Brainstorming. ▪ Exercises ▪ Group Discussion. Team work.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	**To demonstrate his ability to the effectively collaboration and inter-professionalism in class discussions or team works, as well as independently.**	**V1. *Phy*.; V2. *Phy*.**	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. Group Presentation of mini-projects	▪ Participation ▪ Homework's Mini-project(s).

C. Course Content:

No	List of Topics	Contact Hours
1.	***Introduction:*** homogenous and hetergenous catalysis	4
2.	***Homogenous catalysis with metallo organic catalysts:*** The main reactions in homogeneous catalysis include the homogeneity and exchange of ligands (ligands), compound formation, acid-base reactions, redox reactions. Catalytic cycles, elastic and hard catalysis, characterization of homogeneous catalysis.	8
3.	***Homogeneous catalysis industrial processes:*** Examples of some industrial processes, preparation of (Oxo) compounds and production of vinegar, selective oxidation of ethylene, cyclohexane oxidation, Suzuki coupling, asymmetric catalysis: catalysts, commercial applications, asymmetric hydrogenation.	5
4.	***Biocatalysis:*** introduction, kinetics of enzyme-catalyzed reactions, biocatalytic industrial processes, acrylamide preparation from acrylonitrile	3
5	***Heterogeneous catalysis - basics:*** individual steps in the heterogeneous catalysis process, study of kinetics and mechanisms of heterogeneous catalytic reactions, the importance of adsorption in heterogeneous catalysis, kinetic study and mechanisms of heterogeneous catalytic reactions that take place in gas media, Langmuir - Henschlewood mechanism, energy aspects of catalytic activity, performance of Catalyst, inhibition and activation of catalytic factors, characterization of heterogeneous catalysts	5
6	***Forms of catalysts and production of heterogeneous catalysts:*** Production of catalysts	3
7	***Selective catalyst: zeolite***: composition and structure of zeolites, production of zeolites, catalytic properties of zeolites.	3
8	***Heterogeneous catalytic processes in industry***: an overview, examples of industrial processes, manufacture of circulating and rare chemicals	3
9	***Electrocatalysis:*** electrochemical reactions and the study of electrode kinetics, electrical catalysis in fuel cells.	3
10	***Catalyst development, planning and testing:*** Stages of catalyst development, example of catalyst planning	3
11	***Catalysis reactors:*** two-state reactors, three-state reactors, stationary bed reactors, and homogeneous catalysis reactions.	3
12	***The economic importance of catalysts.***	2
Total		45

D. Students Assessment Activities:

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)	weekly	30 %
2.	Midterm Exam	9th week	30 %
3.	Final Exam	17 th week	40 %
4.	Total		100%

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.)

E. Learning Resources and Facilities:

1. References and Learning Resources:

Essential References	***Catalyst Preparation: Science and Engineering***, Regalbuto, J., CRC Press 2016. ISBN 9781420006506. ***Heterogeneous Catalysts for Clean Technology: Spectroscopy, Design, and Monitoring***, Wilson, K.; Lee, A. F., Wiley-VCH 2013. ISBN: 978-3-527-33213-7
Supportive References	None
Electronic Materials	• Catalysis Today • Catalysis Communications • Applied Catalysis B: Environmental • Applied Catalysis A: General • Catalysis Letters Saudi Digital Library
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites.

3. Educational and Research Facilities and Equipment Required:

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology equipment (projector, smart board, software)	**The rooms are equipped with data show, Smart Board,** **WI-FI access.**
Other equipment (depending on the nature of the specialty)	**None**

F. Assessment of Course Quality:

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students	**Direct:** Questionnaire.
	Course Responsible	**Direct:** Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Peer Reviewer	**Direct:** Questionnaire. **Indirect:** External assessor report.
Effectiveness of students assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Quality of learning resources	Students	**Indirect:** Second examiner checklist-Course report.
	Faculty (Academic Advisory-GCC)	**Direct:** course Entrance/Exit. **Indirect:** Observations - Accreditation review.
	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review.
	Course Responsible	
The extent to which CLOs have been achieved	Course Responsible	**Direct:** Exams - Course e-Portfolio.

Assessment Areas/Issues	Assessor	Assessment Methods
		Indirect: Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
Other		

Assessor (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)
Assessment Methods (Direct, Indirect)

G. Specification Approval Data:

COUNCIL /COMMITTEE	Council of Chemistry Department
REFERENCE NO.	10 (No. 2/10)
DATE	21/04/1444- 15/11/2022