هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Inorganic Molecular Spectroscopy**
Course Code:	**CHM 6111**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: **5 (5 Lectures, 0 Lab, 0 Tutorials)**	
2. Course type ☒ Required ☐ Elective	
3. Level/year at which this course is offered: **Level 2/ Year 1**	
4. Pre-requisites for this course (if any)**:** **None**	
5. Co-requisites for this course (if any)**:** **None**	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

The aim of the course is the understanding the basic principles of molecular symmetry and symmetry groups and interpretation of major types of spectroscopy: ultraviolet and visible spectroscopy, infrared spectroscopy, Raman spectroscopy, microwave spectroscopy and *Mössbour* spectroscopy that are tools to address questions of structure and reactivity of organometallic and inorganic materials

2. Course Main Objective

At the end of the course, the students will be able to:

- Recognize the nature of electromagnetic radiation, its properties, the laws of absorption in the visible spectrum, ultraviolet infrared rays, microwave spectroscopy, and the spectroscopy of the *Mössbour*.
- Be familiar with the basics of electronic transport, its rules, and its effect on the colors of inorganic compounds and compatible complexes.
- Describe the applications of spectroscopic techniques on inorganic and coordination compounds.

3. Course Learning Outcomes

3. A: *Inorganic Chemistry Track*

CLOs	*After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recall and apply knowledge of Symmetry Elements and Symmetry Operations.	K1. *Inorg*.; K2. *Inorg*.; K3. *Inorg*.
1.2	To describe the Plane of Symmetry, Inversion Centre, Point groups, Chirality, and Symmetry Operations, and outline its applications.	K1. *Inorg*.; K2. *Inorg*.; K4. *Inorg*.
1.3	To outline Mössbour Spectroscopy and its relation with the Molecular Structure of Inorganic Compounds and Infrared and Raman Spectroscopy, Microwave Spectroscopy Interpretation.	K1. *Inorg*.; K2. *Inorg*. K3. *Inorg*. K4. *Inorg*.
1.4	To state Electronic Absorption Spectroscopy.	K1. *Inorg*.; K2. *Inorg*.; K4. *Inorg*.
2	**Skills:**	
2.1	To summarize Symmetry Elements and Symmetry Operations Concepts with exploring strategies of Plane of Symmetry, Inversion Centre, Point groups, Chirality and Symmetry Operations.	S1. *Inorg*.; S4. *Inorg*.
2.2	To interpret Electronic Absorption Spectroscopy and Molecular transitions, Selection Rule, Morse potential energy diagram.	S2. *Inorg*.; S3.*Inorg*.
2.3	To illustrate a reasonable argument to explain the Molecular vibrations, Raman Spectroscopy using IT for acquiring and analyzing information.	S1. *Inorg*.; S2. *Inorg*.; S3. *Inorg*.; S4. *Inorg*.
2.4	To compare molecular symmetry and symmetry groups of inorganic compounds, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.	S1. *Inorg*.; S3. *Inorg*.; S4. *Inorg*.;
3	**Values:**	
3.1	To demonstrate scientific research, independently and collaborate with groups in relevant topics.	V1. *Inorg*.
3.2	To use his/her ability to be an effective and active collaborator with inter-professionalism in teamwork, and make decisions, develop knowledge, and enhance society's quality as well as independently.	V1. *Inorg*.; V2. *Inorg*.

3. B: ***Organic Chemistry Track***

CLOs *After completion of the course, The Graduate is able*		Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recall and apply knowledge of Symmetry Elements and Symmetry Operations.	K2. *Org.*; K3. *Org*.
1.2	To describe the Plane of Symmetry, Inversion Centre, Point groups, Chirality, and Symmetry Operations, and outline its applications.	K2. *Org.*; K3. *Org.*; K4. *Org.*
1.3	To outline Mössbour Spectroscopy and its relation with the Molecular Structure of Inorganic Compounds and Infrared and Raman Spectroscopy, Microwave Spectroscopy Interpretation.	K2. *Org.*; K4. *Org*.
1.4	To state Electronic Absorption Spectroscopy.	K4. *Org.*
2	**Skills:**	
2.1	To summarize Symmetry Elements and Symmetry Operations Concepts with exploring strategies of Plane of Symmetry, Inversion Centre, Point groups, Chirality and Symmetry Operations.	S1. *Org.*; S2. *Org.*
2.2	To interpret Electronic Absorption Spectroscopy and Molecular transitions, Selection Rule, Morse potential energy diagram.	S2. *Org.*; S3.*Org.*
2.3	To illustrate a reasonable argument to explain the Molecular vibrations, Raman Spectroscopy using IT for acquiring and analyzing information.	S1. *Org.*
2.4	To compare molecular symmetry and symmetry groups of inorganic compounds, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others..	S1. *Org.*; S4. *Org.*
3	**Values:**	
3.1	To demonstrate scientific research, independently and collaborate with groups in relevant topics.	V1. *Org.*
3.2	To use his/her ability to be an effective and active collaborator with inter-professionalism in teamwork, and make decisions, develop knowledge, and enhance society's quality as well as independently.	V1. *Org.*; V2. *Org.*

3. C: *Analytical Chemistry Track*

	CLOs *After completion of the course, The Graduate is able*	**Aligned PLOs**
1	**Knowledge and Understanding**	
1.1	To recall and apply knowledge of Symmetry Elements and Symmetry Operations.	K1. *Anal.*; K2. *Anal.*
1.2	To describe the Plane of Symmetry, Inversion Centre, Point groups, Chirality, and Symmetry Operations, and outline its applications.	K2. *Anal*; K4. *Anal.*
1.3	To outline Mössbour Spectroscopy and its relation with the Molecular Structure of Inorganic Compounds and Infrared and Raman Spectroscopy, Microwave Spectroscopy Interpretation.	K1. *Anal;* K2. *Anal.*
1.4	To state Electronic Absorption Spectroscopy.	K4. *Anal.*
2	**Skills:**	
2.1	To summarize Symmetry Elements and Symmetry Operations Concepts with exploring strategies of Plane of Symmetry, Inversion Centre, Point groups, Chirality and Symmetry Operations.	S1. *Anal.*
2.2	To interpret Electronic Absorption Spectroscopy and Molecular transitions, Selection Rule, Morse potential energy diagram.	S2. *Anal.*; S3. *Anal.*
2.3	To illustrate a reasonable argument to explain the Molecular vibrations, Raman Spectroscopy using IT for acquiring and analyzing information.	S2. *Anal.*; S3. *Anal.*
2.4	To compare molecular symmetry and symmetry groups of inorganic compounds, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others..	S1. *Anal.*; S4. *Anal.*
3	**Values:**	
3.1	To demonstrate scientific research, independently and collaborate with groups in relevant topics.	V1. *Anal.*
3.2	To use his/her ability to be an effective and active collaborator with inter-professionalism in teamwork, and make decisions, develop knowledge, and enhance society's quality as well as independently.	V1. *Anal.*; V2. *Anal.*

3. D: *Physical Chemistry Track*

CLOs	*After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recall and apply knowledge of Symmetry Elements and Symmetry Operations.	K4. *Phy*.
1.2	To describe the Plane of Symmetry, Inversion Centre, Point groups, Chirality, and Symmetry Operations, and outline its applications.	K1. *Phy*.; K4. *Phy*.
1.3	To outline Mössbour Spectroscopy and its relation with the Molecular Structure of Inorganic Compounds and Infrared and Raman Spectroscopy, Microwave Spectroscopy Interpretation.	K2. *Phy*.; K3. *Phy*.; K4. *Phy*.
1.4	To state Electronic Absorption Spectroscopy.	K3. *Phy*.; K4. *Phy*.
2	**Skills:**	
2.1	To summarize Symmetry Elements and Symmetry Operations Concepts with exploring strategies of Plane of Symmetry, Inversion Centre, Point groups, Chirality and Symmetry Operations.	S1. *Phy*.; S2. *Phy*.
2.2	To interpret Electronic Absorption Spectroscopy and Molecular transitions, Selection Rule, Morse potential energy diagram.	S2. *Phy*.; S3. *Phy*.
2.3	To illustrate a reasonable argument to explain the Molecular vibrations, Raman Spectroscopy using IT for acquiring and analyzing information.	S1. *Phy*.; S2. *Phy*.; S3. *Phy*.
2.4	To compare molecular symmetry and symmetry groups of inorganic compounds, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others..	S3. *Phy*.; S4. *Phy*.
3	**Values:**	
3.1	To demonstrate scientific research, independently and collaborate with groups in relevant topics.	V1. *Phy*.
3.2	To use his/her ability to be an effective and active collaborator with inter-professionalism in teamwork, and make decisions, develop knowledge, and enhance society's quality as well as independently.	V1. *Phy*. ; V2. *Phy*.

C. Course Content

No	List of Topics	Contact Hours
1	***Symmetry Elements and Operations:*** Symmetry Elements and Operations, Identity, Proper Rtations: The Plane of Symmetry, The Inversion Centre, Improper rotation.	**5**
2	***Symmetry Operations and Products of Operations:*** Background to point groups, closed groups and new operations, Products of operations, fixed symmetry elements, Improper rotations, Properties of symmetry, The inverse of an operation, The order of the product; Operations that commute, Chirality and symmetry.	**10**
3	***The Point Groups Used with Molecules:*** Molecular Classification using Symmetry Operations, The Nonaxial Groups, The cyclic groups, Axial groups containing mirror planes, Examples of molecules for axial groups containing mirror, Special groups for linear molecules, The Cubic Groups.	**10**
4	***Point Group Representations, Matrices and Basis Sets:*** Symmetry representations and characters, Water, Multiplication tables for character representations, Matrices and symmetry operations, Diagonal and off-diagonal matrix elements, Reducible representations, Degenerate irreducible representations.	**10**
5	***Electronic absorption Spectroscopy:*** Molecular transitions, Selection rule, Morse potential energy diagram, electronic transitions, Orgel diagram, charge transfer spectra.	**5**
6	***Infrared and Raman Spectroscopy*:** Molecular vibrations, force constants, Molecular vibrations and absorption Raman Spectroscopy, polarized Raman lines, Use of symmetry considerations to determine the no. of lines in IR and Raman Spectra, Spectra of gases, applications of Raman and Infrared spectroscopy, Selection rule in Inorganic structure determinations.	**5**
7	***Microwave spectroscopy:*** Basic concept, rotation spectra of simple inorganic compounds, Classification of molecules, rigid rotor model, effect of isotopic substitution on transition frequencies & intensities non rigid rotor, stark effect nuclear and electron spin interaction and effect of external field. Applications of Micro wave Spectroscopy.	**9**
8	***Mössbour spectroscopy:*** Methods of determination of Molecular structure of Inorganic compounds**.**	**6**
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	**To recall and apply knowledge of Symmetry Elements and Symmetry Operations.**	▪ Five hours/week lectures. ▪ Self-study ▪ Homework.	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion ▪ Participation.
1.2	**To describe the Plane of Symmetry, Inversion Centre, Point groups, Chirality, and Symmetry Operations, and outline its applications.**	▪ Five hours/week lectures. ▪ Think, to justify the Plane of symmetry, and its operations, using available references (SDL) online. ▪ Open discussion.	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.3	**To outline Mössbour Spectroscopy and its relation with the Molecular Structure of Inorganic Compounds and Infrared and Raman Spectroscopy, Microwave Spectroscopy Interpretation.**	▪ Five hours/week lectures. ▪ Group Discussion on spectroscopy interpretation of inorganic compounds using available references (SDL) online.	▪ Assignments ▪ Open Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.4	**To state Electronic Absorption Spectroscopy.**	▪ Five hours/week lectures. ▪ Group Discussion using available references (SDL) online	▪ Assignments ▪ Open Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
2.0	**Skills**		
2.1	**To summarize Symmetry Elements and Symmetry Operations Concepts with exploring strategies of Plane of Symmetry, Inversion Centre, Point groups, Chirality and Symmetry Operations.**	▪ Lectures activity ▪ Self-study. ▪ Deep discussion on concepts of Symmetry Elements and Symmetry Operations.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation ▪ Mini -seminar.
2.2	**To interpret Electronic Absorption Spectroscopy and Molecular transitions, Selection Rule, Morse potential energy diagram.**	▪ Practice examples of Electronic absorption Spectroscopy and Molecular transitions achieving. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion ▪ Short Quizzes.
2.3	**To illustrate a reasonable argument to explain the Molecular vibrations, Raman Spectroscopy using IT for acquiring and analyzing information.**	▪ Lectures and Oral Discussions. ▪ Brain storming Exercises	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion. ▪ Participation.

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
2.4	**To compare molecular symmetry and symmetry groups of inorganic compounds, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others..**	▪ Group Discussion and Assignments. ▪ Propose several examples of using principles of molecular symmetry that require reading, writing, and oral presentation. ▪ 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**		
3.1	**To demonstrate scientific research, independently and collaborate with groups in relevant topics.**	▪ Brainstorming. ▪ Exercises ▪ Group Discussion. ▪ Team work.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	**To use his/her ability to be an effective and active collaborator with inter-professionalism in teamwork, and make decisions, develop knowledge, and enhance society's quality as well as independently.**	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	**Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)**	**weekly**	**30 %**
2	**Midterm Exam**	**7 th week**	**30 %**
3	**Final Exam**	**13th week**	**40 %**
4	**Total**		**100%**

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice: • **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;** • **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.** • **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.** • **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***Molecular Symmetry*****,** D. Willock, John Wiley & Sons Ltd. (2009). ISBN 978-0-470-85347-4 (hbk) 978-0-470-85348-1 (pbk). ***Molecular structure and spectroscopy*****,** G. Aruldhas, Prentice-Hall of India Pvt.Ltd , (2004), ISBN-13: 978-8120317499
Essential Reference Materials	***Fundamentals Of Molecular Spectroscopy***, Colin Banwell., Elaine McCash Dr., 4th Ed, 2016 , Banwell , Mc Graw Hill India, ISBN-10: 9352601734.
Electronic Materials	• European Journal Of inorganic Chemistry • American Chemical Society (Relevant Journals) • Saudi Digital Library
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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	

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications (Postgraduate Degree)

Course Title:	Advanced Organic Chemistry
Course Code:	CHM 6121
Program:	Master of Science in Chemistry
Department:	Chemistry
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

Table of Contents

A. Course Identification

1. Credit hours: **5 (5 Lectures, 0 Lab, 0 Tutorials)**	
2. Course type ☒ Required ☐ Elective	
3. Level/year at which this course is offered: **Level 1/ Year 1**	
4. Pre-requisites for this course (if any): **None**	
5. Co-requisites for this course (if any): **None**	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

The course designed as an advanced understanding for the alkylation of anoles, carbon nucleophiles, and the interactions of carbon nucleophiles with carbonyl compounds. The transformation of the functional groups by substitution and protection, the addition reactions of multiple carbon bonds, and the reduction reactions of the multiple carbon bonds and other functional groups will be studied. The reactions of ring addition, thermal elimination, and organometallic compounds of Group 1 and 2 metals are topics of interest to the course. The course will include multi-step preparations, photochemistry, and topics of interest in this subject.

2. Course Main Objective

- Recognize types of organic reactions.
- Understand the nucleophilic reaction that occur in basic medium and differentiate the types of nucleophilic reactions.
- Familiarize the alkylation and acetylation reactions for aromatic compounds and aliphatic compounds.
- Investigate the nucleophilic substitution reactions for sp2 carbons.
- Understand the reactions for preparations of organometallic compounds from metals in groups 1, 2, 1B, and 2B.

3. Course Learning Outcomes

3. A. *Inorganic Chemistry Track*

CLOs	*After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recall and apply knowledge of the Chemistry of functional groups in Organic Reactions.	K1. *Inorg*.; K4. *Inorg*.
1.2	To describe the Nucleophilic and Electrophilic Reactions and factors that influence the reactivity.	K1. *Inorg*.; K2. *Inorg*.; K4. *Inorg*.
Ii	To outline Intramolecular of Functional Groups and Protection groups.	K1. *Inorg*.; K2. *Inorg*.; K4. *Inorg*.
1.4	To state Multistep Syntheses and Photochemistry Reactions in Organic Chemistry.	K2. *Inorg*.; K4. *Inorg*.
2	**Skills:**	
2.1	To summarize concepts of Organic Chemical Reactions and Synthetic Methods.	S1. *Inorg*.; S2. *Inorg*.
2.2	To justify the appropriate mechanism for specific molecules synthesis.	S1. *Inorg*.; S2. *Inorg*.
2.3	To illustrate a reasonable argument to preparations of organometallic compounds from metals in groups 1, 2, 1B, and 2B.	S1. *Inorg*.; S2. *Inorg*.; S3. *Inorg*.
2.4	To compare the functional groups' reactivity on Organic Reactions, accompanied by short reports, operating electronic mail, and Networks in communicating with others.	S1. *Inorg*.; S2. *Inorg*.
3	**Values:**	
3.1	To judge a scientific presentation and scientific projects, and work independently or with other groups on relevant topics, to exchange information	V1. *Inorg*.
3.2	To use all information gained effectively, with research team in class discussions or team works, as well as independently.	V1. *Inorg*.; V2. *Inorg*.

3. B. *Organic Chemistry Track*

CLOs	*After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recall and apply knowledge of the Chemistry of functional groups in Organic Reactions.	K1. *Org*.; K4. *Org*.; K3. *Org*.; K4. *Org*.
1.2	To describe the Nucleophilic and Electrophilic Reactions and factors that influence the reactivity.	K2. *Org*.; K3. *Org*.; K4. *Org*
1.3	To outline Intramolecular of Functional Groups and Protection groups.	K2. *Org*.; K3. *Org*.; K4. *Org*
1.4	To state Multistep Syntheses and Photochemistry Reactions in Organic Chemistry.	K3. *Org*.; K4. *Org*.
2	**Skills:**	
2.1	To summarize concepts of Organic Chemical Reactions and Synthetic Methods.	S1. *Org*.; S4. *Org*.
2.2	To justify the appropriate mechanism for specific molecules synthesis.	S1. *Org*.; S3. *Org*.
2.3	To illustrate a reasonable argument to preparations of organometallic compounds from metals in groups 1, 2, 1B, and 2B.	S1. *Org*.; S2. *Org*.; S4. *Org*.
2.4	To compare the functional groups' reactivity on Organic Reactions, accompanied by short reports, operating electronic mail, and Networks in communicating with others..	S1. *Org*.; S3. *Org*.; S4. *Org*.
3	**Values:**	
3.1	To judge a scientific presentation and scientific projects, and work independently or with other groups on relevant topics, to exchange information	V1. *Org*.
3.2	To use all information gained effectively, with research team in class discussions or team works, as well as independently.	V1. *Org*.; V2. *Org*.

3. C. *Analytical Chemistry Track*

	CLOs *After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recall and apply knowledge of the Chemistry of functional groups in Organic Reactions.	K1. *Anal.*; K4. *Anal.*
1.2	To describe the Nucleophilic and Electrophilic Reactions and factors that influence the reactivity.	K1. *Anal.*; K4. *Anal.*
1.3	To outline Intramolecular of Functional Groups and Protection groups.	K1. *Anal.*; K4. *Anal.*
1.4	To state Multistep Syntheses and Photochemistry Reactions in Organic Chemistry.	K3. *Anal.*; K4. *Anal.*
2	**Skills:**	
2.1	To summarize concepts of Organic Chemical Reactions and Synthetic Methods.	S2. *Anal.*
2.2	To justify the appropriate mechanism for specific molecules synthesis.	S2. *Anal.*
2.3	To illustrate a reasonable argument to preparations of organometallic compounds from metals in groups 1, 2, 1B, and 2B.	S1. *Anal.*; S2. *Anal.*
2.4	To compare the functional groups' reactivity on Organic Reactions, accompanied by short reports, operating electronic mail, and Networks in communicating with others..	S1. *Anal.*; S4. *Anal.*
3	**Values:**	
3.1	To judge a scientific presentation and scientific projects, and work independently or with other groups on relevant topics, to exchange information	V1. *Anal.*
3.2	To use all information gained effectively, with research team in class discussions or team works, as well as independently.	V1. *Anal.* ; V2. *Anal.*

3. D. *Physical Chemistry Track*

CLOs	*After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recall and apply knowledge of the Chemistry of functional groups in Organic Reactions.	K1. *Phy.*; K2. *Phy.*; K4. *Phy.*
1.2	To describe the Nucleophilic and Electrophilic Reactions and factors that influence the reactivity.	K2. *Phy.*; K4. *Phy*
1.3	To outline Intramolecular of Functional Groups and Protection groups.	K2. *Phy.*; K4. *Phy*
1.4	To state Multistep Syntheses and Photochemistry Reactions in Organic Chemistry.	K1. *Phy.*; K3. *Phy.*; K4. *Phy*
2	**Skills:**	
2.1	To summarize concepts of Organic Chemical Reactions and Synthetic Methods.	S1. *Phy.*; S2. *Phy.*
2.2	To justify the appropriate mechanism for specific molecules synthesis.	S1. *Phy.*; S2. *Phy.*
2.3	To illustrate a reasonable argument to preparations of organometallic compounds from metals in groups 1, 2, 1B, and 2B.	S1. *Phy.*; S2. *Phy.*; S3. *Phy*
2.4	To compare the functional groups' reactivity on Organic Reactions, accompanied by short reports, operating electronic mail, and Networks in communicating with others..	S1. *Phy.*; S3. *Phy.*; S4. *Phy.*
3	**Values:**	
3.1	To judge a scientific presentation and scientific projects, and work independently or with other groups on relevant topics, to exchange information	V1. *Phy..*
3.2	To use all information gained effectively, with research team in class discussions or team works, as well as independently.	V1. *Phy..*; V2. *Phy..*

C. Course Content

No	List of Topics	Contact Hours
1	***Enols alkylation and Nucleophilic Carbon:*** Formation of enols, alkylation of enols, Nitrogen as analogy of enols, and imins and their anions.	**5**
2	***Reactions of nucleophilic carbon with carbonyl compounds:*** condensation reactions, addition of amines and ammonium ions.	**5**
3	***Acetylation of nucleophilic carbon:*** olefins reactions, cycloaddition reactions, conjugated addition for carbon as Nu.	**5**
4	***Intramolecular of functional groups, and Protection of functional groups:*** converting alcohols to alkylation agents, substitution reactions of functional groups at carbon sp3; cleavage c-o bond; intramolecular conversion for carboxylic and their derivatives.	**5**
5	***Addition Reactions of carbon multiple bonds;*** electrophilic add for alkenes; electrophilic cycloaddition; electrophilic substitution for alpha carbon; addition of allenes and alkynes; boron compounds in addition reactions.	**5**
6	***Reduction reactions of carbon multiple bonds and other functional groups***; H2 additions; hydrides in group three and four; dissolved metal reductions; reduction of Oxygen.	**5**
7	***Addition reactions for cyclic compounds, and thermal elimination:*** cycloaddition, Diels-Alder reaction and effect of substituents on the reactivity; Lewis acids in D-A reaction; 1,3 addition for dipoles cycles; cyclization using electro chemistry with examples.	**6**
8	***Organo-metallic compounds for group 1 and 2:*** Preparations Li and Mg organic compounds; reactions of Mg and Li compounds; Compounds of groups 2B and 3B; Organo lanthides.	**7**
9	***Carbocations reactions, Carbenes, and Radicals as active intermediates:*** reactions and rearrangements.	**5**
10	***Multisteps syntheses;*** plan and analysis for preparations; examples; preparations in solid phase; combinatorial synthesis.	**6**
11	***Photochemistry reactions in organic chemistry:*** introduction; principals; alkenes reactions; carbonyls; aromatics.	**6**
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	**To recall and apply knowledge of the Chemistry of functional groups in Organic Reactions.**	▪ Five hours/week lectures. ▪ Self-study ▪ Homework.	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion ▪ Participation.
1.2	**To describe the Nucleophilic and Electrophilic Reactions and factors that influence the reactivity.**	▪ Five hours/week lectures. ▪ Think, to justify nucleophilic and electrophilic reactions, using available references (SDL) online. ▪ Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation. ▪
1.3	**To outline Intramolecular of Functional Groups and Protection groups.**	▪ Five hours/week lectures. ▪ Group Discussion using available references (SDL) online.	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.4	**To state Multistep Syntheses and Photochemistry Reactions in Organic Chemistry.**	▪ Five hours/week lectures. ▪ Group Discussion on Multistep and Photochemistry synthesis using available references (SDL) online.	▪ Assignments ▪ Open Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
2.0	**Skills**		
2.1	**To summarize concepts of Organic Chemical Reactions and Synthetic Methods.**	▪ Lectures activity ▪ Self-study. ▪ Deep discussion on the Organic Chemical Reactions concepts.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation ▪ Mini -seminar.
2.2	**To justify the appropriate mechanism for specific molecules synthesis.**	▪ Practice examples of appropriate mechanisms for specific molecules synthesis achieving. ▪ Brainstorming. ▪ Self-study.	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion ▪ Short Quizzes.
2.3	**To illustrate a reasonable argument to preparations of organometallic compounds from metals in groups 1, 2, 1B, and 2B.**	▪ Lectures and Oral Discussions. ▪ Brain storming Exercises	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion.

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
			▪ Participation.
2.4	**To compare the functional groups' reactivity on Organic Reactions, accompanied by short reports, operating electronic mail, and Networks in communicating with others.**	▪ Group Discussion and Assignments. ▪ Suggest examples of the role of the functional group on Organic reactions, which will require reading, writing, and oral presentation. ▪ 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**		
3.1	**To judge a scientific presentation and scientific projects, and work independently or with other groups on relevant topics, to exchange information**	▪ Brain Storms Exercises ▪ Group Discussion	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	**To use all information gained effectively, with research team in class discussions or team works, as well as independently.**	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	**Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)**	**weekly**	**30 %**
2	**Midterm Exam**	**7 th week**	**30 %**
3	**Final Exam**	**13th week**	**40 %**
4	**Total**		**100%**

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice: • **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;** • **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.** • **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.** • **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***Advanced Organic Chemistry Part A: Sturcture and Mechnisms***, Carey, F. A., Sundberg, R. J.; Springer Science, 5th edition, 2007. ISBN: 978-0-387-44897-8. ***Advanced Organic Chemistry Part B: Reactions***, Carey, F. A., Sundberg, R. J.; and Synthesis, Springer Science,(5th edition, 2007. ISBN: 978-0-387-44897-8. ***March's Advanced Organic Chemistry,*** Smith, M. B., March, J.;, 7th edition, Wiley, 2013. ISBN: 978-0-470-46259-1
Essential Reference Materials	NONE
Electronic Materials	• Saudi Digital Library
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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	

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Advanced Analytical Chemistry**
Course Code:	**CHM 6131**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: 5 (5 Lectures, 0 Lab, 0 Tutorials)	
2. Course type ☒ Required ☐ Elective	
3. Level/year at which this course is offered: Level 1/ Year 1	
4. Pre-requisites for this course (if any): None	
5. Co-requisites for this course (if any): None	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

This course is designed to provide comprehensive topics of sampling and modern sample preparation techniques. The course will cover the classical methods of analysis (gravimetric methods and volumetric methods). The topics include advanced aspects of Spectroscopic methods of analysis, Electro-chemical methods of analysis, and Chromatographic techniques.

2. Course Main Objective

- Recognize the required techniques for a variety of sampling types.
- Develop awareness with handlings samples preparation in an appropriate way.
- Be familiar with volumetric and gravimetric analysis and their application in different fields.
- Develop awareness with spectral, electrochemical, and chromatographic methods; and choosing the appropriate technique.

3. Course Learning Outcomes

3. A. *Inorganic Chemistry Track*

CLOs	*After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recall the principles of a wide range of modern analytical methods of sampling types.	K1. *Inorg.*; K4. *Inorg.*
1.2	To list principles in Analytical Chemistry.	K1. *Inorg.*; K4. *Inorg.*
1.3	To describe Spectral Methods applications in Analytical Chemistry.	K2. *Inorg.*; K3. *Inorg.*
1.4	To memorize the Chromatographic and Electrochemical Methods.	K1. *Inorg.*; K4. *Inorg.*
2	**Skills:**	
2.1	To analyze problems and explore strategies for Volumetric and Gravimetric Methods applications.	S1. *Inorg.*; S2. *Inorg.*; S3. *Inorg.*
2.2	To interpret the obtained data from different Spectral Methods.	S2. *Inorg.*; S3. *Inorg.*
2.3	To choose the appropriate techniques in Electrochemical analytical methods for a specific sample.	S2. *Inorg.*; S3. *Inorg.*
2.4	To compare applying analytical chemistry techniques in the industry and their impact on KSA, accompanying mini- Reports, operating electronic mail, and Network in communicating with others.	S1. *Anal.*; S3. *Inorg.*; S4. *Inorg.*
3	**Values:**	
3.1	To show scientific activity based on integrity, academic ethical practices to find solutions for scientific and social issues, and a commitment to responsible citizenship and using IT	V1. *Inorg.*
3.2	To Appraise effectively in research or professional groups and make decisions, develop knowledge, enhance society's quality, and contribute to its advancement.	V1. *Inorg.*; V2. *Inorg.*

3. B. ***Organic Chemistry Track***

CLOs *After completion of the course, The Graduate is able*		Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recall the principles of a wide range of modern analytical methods of sampling types.	K1. *Org.*; K4. *Org.*
1.2	To list principles in Analytical Chemistry.	K2. *Org.*
1.3	To describe Spectral Methods applications in Analytical Chemistry.	K2. *Org.*; K3. *Org.*
1.4	To memorize the Chromatographic and Electrochemical Methods.	K2. *Org.*; K3. *Org.*
2	**Skills:**	
2.1	To analyze problems and explore strategies for Volumetric and Gravimetric Methods applications.	S1. *Org.*; S4. *Org.*
2.2	To interpret the obtained data from different Spectral Methods.	S2. *Org.*; K3. *Org.*
2.3	To choose the appropriate techniques in Electrochemical analytical methods for a specific sample.	S2. *Org.*; S3. *Org.*
2.4	To compare applying analytical chemistry techniques in the industry and their impact on KSA, accompanying mini- Reports, operating electronic mail, and Network in communicating with others.	S1. *Org.*; S3. *Org.*; S4. *Org.*
3	**Values:**	
3.1	To show scientific activity based on integrity, academic ethical practices to find solutions for scientific and social issues, and a commitment to responsible citizenship and using IT	V1. *Org.*
3.2	To Appraise effectively in research or professional groups and make decisions, develop knowledge, enhance society's quality, and contribute to its advancement.	V1. *Org.*; V2. *Org.*

3. C. *Analytical Chemistry Track*

CLOs	*After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recall the principles of a wide range of modern analytical methods of sampling types.	K1. *Anal.*; K2. *Anal.*; K3. *Anal.*; K4. *Anal.*
1.2	To list principles in Analytical Chemistry.	K2. *Anal.*; K3. *Anal.*; K4. *Anal.*
1.3	To describe Spectral Methods applications in Analytical Chemistry.	K2. *Anal.*; K3. *Anal.*; K4. *Anal*
1.4	To memorize the Chromatographic and Electrochemical Methods.	K1. *Anal.*; K2. *Anal.*; K4. *Anal*
2	**Skills:**	
2.1	To analyze problems and explore strategies for Volumetric and Gravimetric Methods applications.	S1. *Anal.*; S2. *Anal.*; S3. *Anal*
2.2	To interpret the obtained data from different Spectral Methods.	S2. *Anal.*; S3. *Anal.*
2.3	To choose the appropriate techniques in Electrochemical analytical methods for a specific sample.	S1. *Anal.*; S2. *Anal.*; S3. *Anal*
2.4	To compare applying analytical chemistry techniques in the industry and their impact on KSA, accompanying mini- Reports, operating electronic mail, and Network in communicating with others.	S1. *Anal.*; S4. *Anal.*
3	**Values:**	
3.1	To show scientific activity based on integrity, academic ethical practices to find solutions for scientific and social issues, and a commitment to responsible citizenship and using IT	V1. *Anal.*
3.2	To appraise effectively in research or professional groups and make decisions, develop knowledge, enhance society's quality, and contribute to its advancement.	V1. *Anal.*; V2. *Anal.*

3. D. ***Physical Chemistry Track***

	CLOs *After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	**To recall the principles of a wide range of modern analytical methods of sampling types.**	**K2. *Phy.*; K4. *Phy.***
1.2	**To list principles in Analytical Chemistry.**	**K2. *Phy.*; K4. *Phy.***
1.3	**To describe Spectral Methods applications in Analytical Chemistry.**	**K2. *Phy.*; K3. *Phy.*; K4. *Phy.***
1.4	**To memorize the Chromatographic and Electrochemical Methods.**	**K4. *Phy.***
2	**Skills:**	
2.1	**To analyze problems and explore strategies for Volumetric and Gravimetric Methods applications.**	**S2. *Phy.*; S3. *Phy***
2.2	**To interpret the obtained data from different Spectral Methods.**	**S2. *Phy.*; S3. *Phy.***
2.3	**To choose the appropriate techniques in Electrochemical analytical methods for a specific sample.**	**S1. *Phy.*; S2. *Phy.***
2.4	**To compare applying analytical chemistry techniques in the industry and their impact on KSA, accompanying mini- Reports, operating electronic mail, and Network in communicating with others.**	**S2. *Phy.*; S4. *Phy.***
3	**Values:**	
3.1	**To show scientific activity based on integrity, academic ethical practices to find solutions for scientific and social issues, and a commitment to responsible citizenship and using IT**	**V1. *Phy.***
3.2	**To Appraise effectively in research or professional groups and make decisions, develop knowledge, enhance society's quality, and contribute to its advancement.**	**V1. *Phy.*; V2. *Phy.***

C. Course Content

No	List of Topics	Contact Hours
1	***Various sampling techniques of organic, inorganic analytes.***	**5**
2	***Scientific principles in analytical chemistry***	**10**
3	***Volumetric and Gravimetric Methods:*** Principle, Stoichiometric calculations in Volumetric and Gravimetric Analysis and their application	**10**
4	***Spectral Methods:*** Recent techniques in spectroscopic methods of analysis, Infrared spectroscopy (Definition - Theory – Infrared instruments), Ultraviolet/Visible spectroscopy (Principle – Instrumentation – Applications), and Atomic spectroscopy (Principle – Instrumentation – Applications).	**51**
5	***Electrochemical Methods:*** Simple introduction, Potentiometry, conductometry, coulometry, polarography, amperometry, voltammetry.	**10**
6	***Chromatographic Methods*:** Principles, Theory and different types.	**10**
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	**To recall the principles of a wide range of modern analytical methods of sampling types.**	▪ Five hours/week lectures. ▪ Self-study. ▪ Homework.	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion ▪ Participation.
1.2	**To list principles in Analytical Chemistry.**	▪ Five hours/week lectures. ▪ Think, to justify the principles of analytical chemistry, available references (SDL) online. ▪ Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.3	**To describe Spectral Methods applications in Analytical Chemistry.**	▪ Five hours/week lectures. ▪ Group Discussion using available references (SDL) online.	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.4	**To state the Chromatographic and Electrochemical Methods.**	▪ Five hours/week lectures. ▪ Group Discussion Analytical methods for separation using available references online.	▪ Assignments ▪ Open Discussions. ▪ Literatures Survey ▪ Mini-seminars. ▪ Participation.
2.0	Skills		
2.1	**To analyze problems and explore strategies for Volumetric and Gravimetric Methods applications.**	▪ Lectures activity ▪ Self-study. ▪ Deep discussions on the Volumetric and Gravimetric Methods applications.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation ▪ Mini -seminar.
2.2	**To interpret the obtained data from different Spectral Methods.**	▪ Practice examples Spectral Methods interpretation. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion ▪ Short Quizzes.
2.3	**To choose the appropriate techniques in Electrochemical analytical methods for a specific sample.**	▪ Lectures and Oral Discussions. ▪ Brainstorming. ▪ Self-study.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion. ▪ Participation.
2.4	**To compare applying analytical chemistry techniques in the industry and**	▪ Group Discussion and Assignments.	▪ Oral Discussion. ▪ Quizzes, and Exams.

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
	their impact on KSA, accompanying mini- Reports, operating electronic mail, and Network in communicating with others.	▪ Suggest application of analytical chemistry techniques in the industry and its impact in KSA, which will require reading, writing, and oral presentation. ▪ Encourage students to use electronic mail to submit Home Exams and Assignments.	▪ Giving marks for Oral Discussion in Lectures. ▪ Marks given for Assignments.
3.0	**Values**		
3.1	**To show scientific activity based on integrity, academic ethical practices to find solutions for scientific and social issues, and a commitment to responsible citizenship and using IT**	▪ Brain Storms Exercises ▪ Group Discussion	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	**To Appraise effectively in research or professional groups and make decisions, develop knowledge, enhance society's quality, and contribute to its advancement.**	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	**Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)**	**weekly**	**30 %**
2	**Midterm Exam**	**7th week**	**30 %**
3	**Final Exam**	**13^{th} week**	**40 %**
4	**Total**		**100%**

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice:

- **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;**
- **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.**
- **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.**
- **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***Fundamentals of analytical chemistry,*** Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch. 9th Edition. ISBN-13: 978-0-495-55828-6. ***Analytical Chemistry,*** Gary D. Christian, Purnendu K. (Sandy) Dasgupta, Kevin A. Schug., 7th Edition. ISBN: 978-0-470-88757-8
Essential Reference Materials	None
Electronic Materials	• The Journal of Analytical Chemistry • Saudi Digital Library •
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites.

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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.
	Course Responsible	**Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد NCAAA

T15

Course Specifications (Postgraduate Degree)

Course Title:	Advanced Physical Chemistry
Course Code:	CHM 6141
Program:	Master of Science in Chemistry
Department:	Chemistry
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

Table of Contents

A. Course Identification

1. Credit hours: 5 (5 Lectures, 0 Lab, 0 Tutorials)	
2. Course type ☒ Required ☐ Elective	
3. Level/year at which this course is offered: Level 2/ Year 1	
4. Pre-requisites for this course (if any): None	
5. Co-requisites for this course (if any): None	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

This course is provided a comprehensive treatment of physical chemistry for advanced students in a reasonable manner. It will cover all important and advanced topics in physical chemistry. This course explores materials and materials processes from the perspective of thermodynamics and kinetics. The thermodynamics aspect includes laws of thermodynamics, solution theory and equilibrium diagrams. The kinetics aspect includes diffusion, phase transformations, and the development of microstructure.

2. Course Main Objective

- Know, the basic principles of physical chemistry, in particular, Kinetics, Thermodynamics and Materials Science.
- Describe the advanced principles of thermodynamic, and classical thermodynamics.
- Be familiar with materials and materials processes from the perspective of thermodynamics and kinetics.
- Familiarize the classifications of materials, solid solutions, alloys, phase diagrams, composites, advanced materials.
- Recognize the different application of materials in the industry: metallurgical industry.

3. Course Learning Outcomes

3. A. *Inorganic Chemistry Track*

CLOs	*After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recall knowledge of Classical Physical Chemistry and Chemical Kinetics Concepts.	K1. *Inorg*.; K4. *Inorg*
1.2	To list and memorize different concepts of Thermodynamic Laws and the Physical Properties of Materials	K2. *Inorg*.; K4. *Inorg*
1.3	To record the Statistical Thermodynamics.	K4. *Inorg*
1.4	To describe Materials and Materials Processes from the Perspective of Thermodynamics and Kinetics.	K1. *Inorg*.; K2. *Inorg*
2	**Skills:**	
2.1	To analyze problems and explore strategies for their solution, with justify the optimum approaches to appropriate Thermodynamics Laws and Kinetics Laws.	S1. *Inorg*.; S2. *Inorg*
2.2	To interpret the catalytic reactions on variation operational conditions and contrast scientific data on materials and arguments clearly and correctly.	S1. *Inorg*.; S2. *Inorg*.; S3. *Inorg*.
2.3	To illustrate reasonable arguments for classifications of materials, solid solutions, alloys, phase diagrams, composites, and advanced materials.	S2. *Inorg*.; S3. *Inorg*.
2.4	To reorganize the development of microstructure and material science in the industry: and its impact in KSA, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.	S1. *Inorg*.; S3. *Inorg*.; S4. *Inorg*.
3	**Values:**	
3.1	To demonstrate scientific research, independently and collaborate with groups in relevant topics.	V1. *Inorg*.
3.2	To use all information gained effectively, with research team in class discussions or team works, as well as independently.	V1. *Inorg*.; V2. *Inorg*.

3. B. ***Organic Chemistry Track***

CLOs	*After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	**To recall knowledge of Classical Physical Chemistry and Chemical Kinetics Concepts.**	**K1. *Org.*; K2. *Org.***
1.2	**To list and memorize different concepts of Thermodynamic Laws and the Physical Properties of Materials**	**K2. *Org.*; K4. *Org.***
1.3	**To record the Statistical Thermodynamics.**	**K2. *Org.***
1.4	**To describe Materials and Materials Processes from the Perspective of Thermodynamics and Kinetics.**	**K1. *Org.*; K2. *Org.*; K3. *Org.***
2	**Skills:**	
2.1	**To analyze problems and explore strategies for their solution, with justify the optimum approaches to appropriate Thermodynamics Laws and Kinetics Laws.**	**S1. *Org.*** .
2.2	**To interpret the catalytic reactions on variation operational conditions and contrast scientific data on materials and arguments clearly and correctly.**	**S1. *Org.*; S2. *Org.*; S3. *Org.***
2.3	**To illustrate reasonable arguments for classifications of materials, solid solutions, alloys, phase diagrams, composites, and advanced materials.**	**S1. *Org.*; S2. *Org.*; S3. *Org.***
2.4	**To reorganize the development of microstructure and material science in the industry: and its impact in KSA, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.**	**S1. *Org.*; S3. *Org.*; S4. *Org.***
3	**Values:**	
3.1	**To demonstrate scientific research, independently and collaborate with groups in relevant topics.**	**V1. *Org.***
3.2	**To use all information gained effectively, with research team in class discussions or team works, as well as independently.**	**V1. *Org.*; V2. *Org.***

3. C. *Analytical Chemistry Track*

CLOs	*After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recall knowledge of Classical Physical Chemistry and Chemical Kinetics Concepts.	K1. *Anal.*; K4. *Anal.*
1.2	To list and memorize different concepts of Thermodynamic Laws and the Physical Properties of Materials	K1. *Anal.*; K4. *Anal.*;
1.3	To record the Statistical Thermodynamics.	K4. *Anal.*
1.4	To describe Materials and Materials Processes from the Perspective of Thermodynamics and Kinetics.	K1. *Anal.*; K4. *Anal.*
2	**Skills:**	
2.1	To analyze problems and explore strategies for their solution, with justify the optimum approaches to appropriate Thermodynamics Laws and Kinetics Laws.	S1. *Anal.*; S2. *Anal.*
2.2	To interpret the catalytic reactions on variation operational conditions and contrast scientific data on materials and arguments clearly and correctly.	S1. *Anal.*; S2. *Anal.*; S3. *Anal.*
2.3	To illustrate reasonable arguments for classifications of materials, solid solutions, alloys, phase diagrams, composites, and advanced materials.	S1. *Anal.*; S2. *Anal.*; S3. *Anal.*
2.4	To reorganize the development of microstructure and material science in the industry: and its impact in KSA, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.	S1. *Anal.*; S3. *Anal.*; S4. *Anal.*
3	**Values:**	
3.1	To demonstrate scientific research, independently and collaborate with groups in relevant topics.	V1. *Anal.*
3.2	To use all information gained effectively, with research team in class discussions or team works, as well as independently.	V1. *Anal.*; V2. *Anal.*

3. D. *Physical Chemistry Track*

	CLOs *After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recall knowledge of Classical Physical Chemistry and Chemical Kinetics Concepts.	K1. *Phy.*; K2. *Phy.*; K3. *Phy.*; K4. *Phy*
1.2	To list and memorize different concepts of Thermodynamic Laws and the Physical Properties of Materials	K1. *Phy.*; K2. *Phy.*; K3. *Phy.*;
1.3	To record the Statistical Thermodynamics.	K1. *Phy.*
1.4	To describe Materials and Materials Processes from the Perspective of Thermodynamics and Kinetics.	K1. *Phy.*; K2. *Phy.*; K4. *Phy.*
2	**Skills:**	
2.1	To analyze problems and explore strategies for their solution, with justify the optimum approaches to appropriate Thermodynamics Laws and Kinetics Laws.	S1. *Phy.*; S2. *Phy.*; S3. *Phy.*
2.2	To interpret the catalytic reactions on variation operational conditions and contrast scientific data on materials and arguments clearly and correctly.	S1. *Phy.*; S2. *Phy.*; S3. *Phy.*
2.3	To illustrate reasonable arguments for classifications of materials, solid solutions, alloys, phase diagrams, composites, and advanced materials.	S1. *Phy.*; S2. *Phy.*; S3. *Phy.*; S4. *Phy.*;
2.4	To reorganize the development of microstructure and material science in the industry: and its impact in KSA, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.	S1. *Phy.*; S2. *Phy.*; S4. *Phy.*
3	**Values:**	
3.1	To demonstrate scientific research, independently and collaborate with groups in relevant topics.	V1. *Phy.*
3.2	To use all information gained effectively, with research team in class discussions or team works, as well as independently.	V1. *Phy.*; V2. *Phy.*;

C. Course Content

No	List of Topics	Contact Hours
Kinetics:		
1	***Introduction***, The Rate Equation and Rate Laws, Reactions and Thermodynamic Equilibrium, Temperature Dependence of the Rate, ***Integrated Rate Equations***, Time Dependence of Concentrations in Reactions of Different Orders, ***Coupled Reactions in Flow Reactors***, The Steady-state Approximation, Coupled Reactions in Batch Reactors, ***Catalytic Reactions,*** Langmuir Adsorption Isotherms, Competitive Adsorption.	**20**
Thermodynamics:		
2	***General Introduction***: Classical thermodynamics: the first law of thermodynamics, ***Classical thermodynamics revisited:*** the second and third law of thermodynamics, ***Basic probability theory***, The Boltzmann distribution, ***Ensembles in statistical thermodynamics and partition function***, Calculation of state functions, Kinetic theory of gases, Lifson-Roig theory.	**20**
Materials Science:		
3	***Introduction***, the classifications of materials, solid solutions, alloys, phase diagrams, ***Composites***, advanced materials, the determination of the crystal structures, crystal imperfections, X-ray Diffractions, ***Physical, optical properties***, LASER, electrical, thermal, magnetic and mechanical properties of materials, ***interaction of radiation with the matter***, applications of materials in the industry: metallurgical industry.	**20**
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	**To recall knowledge of Classical Physical Chemistry and Chemical Kinetics Concepts.**	▪ Five hours/week lectures. ▪ Self-study • Homework.	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion ▪ Participation.
1.2	**To list and memorize different concepts of Thermodynamic Laws and the Physical Properties of Materials**	▪ Five hours/week lectures. ▪ Think, to justify thermodynamic laws and the physical properties of materials, using available references (SDL) online. ▪ Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.3	**To record the Statistical Thermodynamics.**	▪ Five hours/week lectures. ▪ Group Discussion using available references (SDL) online.	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.4	**To describe Materials and Materials Processes from the Perspective of Thermodynamics and Kinetics.**	▪ Five hours/week lectures. ▪ Group Discussion on materials processes thermodynamically and kinetically using available references (SDL) online.	▪ Assignments ▪ Open Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
2.0	**Skills**		
2.1	**To analyze problems and explore strategies for their solution, with justify the optimum approaches to appropriate Thermodynamics Laws and Kinetics Laws.**	▪ Lectures activity ▪ Self-study. ▪ Deep discussion on the appropriate thermodynamics laws and kinetics laws approaches.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation ▪ Mini -seminar.
2.2	**To interpret the catalytic reactions on variation operational conditions and contrast scientific data on materials and arguments clearly and correctly.**	▪ Practice examples of the interpretation of the catalytic reactions for a variety of operational conditions achieving. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion ▪ Short Quizzes.

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
2.3	**To illustrate reasonable arguments for classifications of materials, solid solutions, alloys, phase diagrams, composites, and advanced materials.**	▪ Lectures ▪ Oral Discussions. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion. ▪ Participation.
2.4	**To reorganize the development of microstructure and material science in the industry: and its impact in KSA, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.**	▪ Group Discussion and Assignments ▪ Suggest examples micro-structure and material science in the industry and its impact in KSA, which will require reading, writing, and oral presentation. ▪ 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**		
3.1	**To demonstrate scientific research, independently and collaborate with groups in relevant topics.**	▪ Brain Storms Exercises ▪ Group Discussion.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	**To use all information gained effectively, with research team in class discussions or team works, as well as independently.**	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects.	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	**Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)**	**weekly**	**30 %**
2	**Midterm Exam**	**7th week**	**30 %**
3	**Final Exam**	**13th week**	**40 %**
4	**Total**		**100%**

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice: • **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;** • **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.** • **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.** • **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***Concepts of Modern Catalysis and Kinetics,*** Chorkendorff, I.; Niemantsverdriet, J. W., Wiley-VCH, 2003. ***Thermodynamics, Statistical Thermodynamics and*** Kinetics. Engel, Th., Reid, Ph., Pearson, Boston, 3rd edition. 2012. ISBN-10: 0321766180
Essential Reference Materials	**None**
Electronic Materials	• The Journal of Physical Chemistry A • The Journal of Physical Chemistry B • The Journal of Physical Chemistry C • The Journal of Physical Chemistry • The Journal of Physical and Colloid Chemistry • The Journal of Physical Chemistry Letters • Saudi Digital Library
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites.

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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	

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Research Methods in Chemistry**
Course Code:	**CHM 6190**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: **2 (2 Lectures, 0 Lab, 0 Tutorials)**	
2. Course type ☒ Required ☐ Elective	
3. Level/year at which this course is offered: **Level 3/ Year 1**	
4. Pre-requisites for this course (if any): **CHM 6111, CHM 6121, CHM 6131, CHM 6141**	
5. Co-requisites for this course (if any): **None**	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	24	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	24
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		24

B. Course Objectives and Learning Outcomes

1. Course Description

This course is designed to develop and improve the capability of graduate students to carry out search and interpret as well summarize the literature survey relevant for research topics. Students will practice through a series of exercises in a proposal of a simple project, logic thinking in building up methodology and justify the applied techniques, and finally writing a report. A presentation of the proposed project will improve students understanding of how scientific questions are developed and posed through proposals and dissemination of research results.

2. Course Main Objective

- Understand the scientific research, and its methods.
- Recognize various designs and methodologies of scientific research.
- Provide suggestions for treatment of research challenges in a scientific way.
- Make bibliography about the current state of the art of specific scientific subjects
- Read, comment and summarize scientific papers
- Make a critical assessment of scientific work conducted by others.
- Select suitable literature databases for a given topic.
- Offer scientific oral presentation and writing scientific article or report.

3. Course Learning Outcomes

This Course will be dedicated for all tracks.

3. A. *Inorganic Chemistry Track*

	CLOs *After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To state Ethics in Chemistry	K1. *Inorg*.; K2. *Inorg*.
1.2	To outline the appropriate methods and routes in formulating a research problem or topic.	K1. *Inorg*.; K2. *Inorg*. K3. *Inorg*.; K4. *Inorg*.;
1.3	To list in-depth the chemical literatures survey analysis with comparing the scientific approach	K3. *Inorg*.; K4. *Inorg*.
1.4	To recognize a critical assessment of scientific work conducted by others.	K3. *Inorg*.; K4. *Inorg*.
2	**Skills:**	
2.1	To develop experience in searching and assessing current literature.	S1. *Inorg*.; S4. *Inorg*.
2.2	To summarize the literature survey the applied methods and techniques used	S1. *Inorg*. ; S2. *Inorg*.; S4. *Inorg*.
2.3	To analyze and contrast the literature survey with instructor guidance.	S1. *Inorg*.; S2. *Inorg*.
2.4	To evaluate a solution for a selected problem, accompanying writing of mini-Reports, operating electronic mail, and Networks in communicating with others.	S1. *Inorg*.; S3. *Inorg*.; S4. *Inorg*.
3	**Values:**	
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. *Inorg*.; V2. *Inorg*.
3.2	To appraise effectively the collaboration and inter-professionalism in class discussions or team works, as well as independently.	V1. *Inorg*.; V2. *Inorg*.

3. B. ***Organic Chemistry Track***

CLOs *After completion of the course, The Graduate is able*		Aligned PLOs
1	**Knowledge and Understanding**	
1.1	**To state Ethics in Chemistry**	**K1.** ***Org.***; **K2.** ***Org.***
1.2	**To outline the appropriate methods and routes in formulating a research problem or topic.**	**K1.** ***Org.***; **K2.** ***Org.***; **K3.** ***Org.***; **K4.** ***Org.***;
1.3	**To list in-depth the chemical literatures survey analysis with comparing the scientific approach**	**K3.** ***Org.***; **K4.** ***Org.***
1.4	**To recognize a critical assessment of scientific work conducted by others.**	**K3.** ***Org.***; **K4.** ***Org.***
2	**Skills:**	
2.1	**To develop experience in searching and assessing current literature.**	**S1.** ***Org.***; **S4.** ***Org.***
2.2	**To summarize the literature survey the applied methods and techniques used**	**S1.** ***Org.*** ; **S2.** ***Org.***; **S4.** ***Org.***
2.3	**To analyze and contrast the literature survey with instructor guidance.**	**S1.** ***Org.***; **S2.** ***Org.***
2.4	**To evaluate a solution for a selected problem, accompanying writing of mini- Reports, operating electronic mail, and Networks in communicating with others..**	**S1.** ***Org.***; **S3.** ***Org.***; **S4.** ***Org.***
3	**Values:**	
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.** ***Org.***; **V2.** ***Org.***
3.2	**To appraise effectively the collaboration and inter-professionalism in class discussions or team works, as well as independently.**	**V1.** ***Org.***; **V2.** ***Org.***

3. C. *Analytical Chemistry Track*

	CLOs *After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To state Ethics in Chemistry	K1. *Anal.*; K2. *Anal.*
1.2	To outline the appropriate methods and routes in formulating a research problem or topic.	K1. *Anal.*; K2. *Anal.*; K3. *Anal.*; K4. *Anal.*
1.3	To list in-depth the chemical literatures survey analysis with comparing the scientific approach	K3. *Anal.*; K4. *Anal.*;
1.4	To recognize a critical assessment of scientific work conducted by others.	K3. *Anal.*; K4. *Anal.*
2	**Skills:**	
2.1	To develop experience in searching and assessing current literature.	S1. *Anal.*; S4. *Anal.*
2.2	To summarize the literature survey the applied methods and techniques used	S1. *Anal.*; S2. *Anal.*; S4. *Anal.*
2.3	To analyze and contrast the literature survey with instructor guidance.	S1. *Anal.*; S2. *Anal.*
2.4	To evaluate a solution for a selected problem, accompanying writing of mini- Reports, operating electronic mail, and Networks in communicating with others.	S1. *Anal.*; S3. *Anal.*; S4. *Anal.*
3	**Values:**	
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. *Anal.*; V2. *Anal.*
3.2	To appraise effectively the collaboration and inter-professionalism in class discussions or team works, as well as independently.	V1. *Anal.*; V2. *Anal.*

4. D. ***Physical Chemistry Track***

	CLOs *After completion of the course, The Graduate is able*	**Aligned PLOs**
1	**Knowledge and Understanding**	
1.1	To state Ethics in Chemistry	K1. *Phy.*; K2. *Phy.*
1.2	To outline the appropriate methods and routes in formulating a research problem or topic.	K1. *Phy.*; K2. *Phy.*; K3. *Phy.*; K4 *Phy.*
1.3	To list in-depth the chemical literatures survey analysis with comparing the scientific approach	K3. *Phy.*; K4. *Phy.*
1.4	To recognize a critical assessment of scientific work conducted by others.	K3. *Phy.*; K4. *Phy.*
2	**Skills:**	
2.1	To develop experience in searching and assessing current literature.	S1. *Phy.*; S4. *Phy.*
2.2	To summarize the literature survey the applied methods and techniques used	S1. *Phy.*; S2. *Phy.* S4. *Phy.*;
2.3	To analyze and contrast the literature survey with instructor guidance.	S1. *Phy.*; S2. *Phy.*
2.4	To evaluate a solution for a selected problem, accompanying writing of mini- Reports, operating electronic mail, and Networks in communicating with others.	S1. *Phy.*; S3. *Phy.* S4. *Phy.*
3	**Values:**	
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.*; V2. *Phy.*
3.2	To appraise effectively the collaboration and inter-professionalism in class discussions or team works, as well as independently.	V1 *Phy.*; V2. *Phy.*

C. Course Content

No	List of Topics	Contact Hours
1	***Ethics in Chemistry*: Professional discussion of chemistry, Identifying "hot topics" in chemistry research, sharpening the awareness of chemists for ethical, social and legal implications of their professional practice. IMSIU Ethical Standards **rule** https://units.imamu.edu.sa/deanships/SR/Documents/الأخلاقيات%20العلمية/لائحة-الحماية.pdf .	1
2	***Research: a way of thinking:*** A way to gather evidence for your practice, Applications of research, Type of research, application perspective, objectives perspective, Paradigms of research.	3
3	***The research process:*** Deciding what to research, Formulating a research problem, Reviewing the literature, Summarizing the literature reviews, Constructing hypotheses, Conceptualizing a research design, exchanging reading, discussing and organizing ideas, Steps in conducting research, Designing a scientific experiment, experimental optimization, performing, collecting and organizing data, Draw the conclusions, justify the research objective.	5
4	***Elements of a primary research article, References Types, Bibliographies:*** Select a problem and reviewing the literature, open discussions about obtained chemical literature survey, how to search and how to justify keywords in the search library database and develop effective techniques.	4
5	***Analyse, set a contrast, compare and review scientific literature:*** provide the available literature, open discussion how to analyze, how to compare the scientific approaches to solve the problem, how to review the chemical literature to build up your approach	2
6	***Group Discussion of a research proposal, applied methodology to build up experimental part, writing summaries, peer review:*** Review the literature survey for a selected problem, open discussion about the framework concept to solve the problem, build up experimental part, Guide for critiquing a research article or report, differences between summarizing and critiquing	**2**
7	***Introduction tontific Presentations and how to design an effective and potential presentation, informative outlines:*** Preparation the scientific presentation, write the clear abstract, Organize all obtained information in the Scientific presentation, how to organize the introduction and how to present the concept of the research article, how to use the appropriate scientific details and information in appropriate scientific language. How to organize and present the materials	**5**
8	***Elements of Scientific writing Grant Proposals:*** What are reviewers looking for? how to choose appropriate literatures relevant for selected research topics; how to attract the reviewers for your proposal; checklist for research proposal.	**4**
Total		22

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	To state Ethics in Chemistry.	▪ Two hours/week lectures. ▪ Students are encouraged to make regular visits during office hours where they can ask any question about the course. ▪ Self-study	▪ Regular Exams. ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion ▪ Participation.
1.2	To outline the appropriate methods and routes in formulating a research problem or topic.	• 2 hours are weekly containing guidance to gather and formulate the research problem. • Think and talk to conceptualize the research design with optimization. • Open discussion.	▪ Oral Discussion ▪ Participation. ▪ Written mini-reports for evaluation.
1.3	To list in-depth the chemical literatures survey analysis with comparing the scientific approach	▪ Evaluate and discuss on chemical literatures survey analysis. ▪ Group discussion	▪ Oral Discussion ▪ Participation. ▪ Mini-reports for evaluation.
1.4	To recognize a critical assessment of scientific work conducted by others.	▪ 2 hours /week lectures. ▪ Group Discussion on critical assessment of scientific work conducted by others using available references (SDL) online.	▪ Oral Discussion ▪ Participation. ▪ Mini-reports for evaluation
2.0	**Skills**		
2.1	To develop experience in searching and assessing current literature.	▪ Lectures activity. ▪ Self-study ▪ Evaluate weekly Independent developing through Group discussion	▪ Continuous evaluation- written test. ▪ Written report ▪ Oral discussion
2.2	To summarize the literature survey the applied methods and techniques used	▪ Lectures activity. ▪ Self-study. ▪ Follow up Independent development in preparing a research	▪ Continuous evaluation - written test. ▪ Written report ▪ Oral discussion ▪ Presentation

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
		topic or scientific presentation.	
2.3	**To analyze and contrast the literature survey with instructor guidance.**	▪ Independent and group literature survey analysis	▪ Continuous evaluation ▪ Written report ▪ Oral discussion
2.4	**To evaluate a solution for a selected problem, accompanying writing of mini-Reports, operating electronic mail, and Networks in communicating with others.**	▪ Group Discussion and Assignments ▪ Suggest several examples of research topics, which will require reading, writing, and oral presentation.	▪ Oral Discussion. ▪ Quizzes, and Exams. ▪ Giving marks for Oral Discussion in Lectures. ▪ Written test.
3.0	**Values**		
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.**	▪ Brain Storms ▪ Group Discussion.	▪ Continuous evaluation via Oral Presentation with marks. ▪ Written report.
3.2	**To appraise effectively the collaboration and inter-professionalism in class discussions or team works, as well independently.**	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects. ▪ Reading IMSIU ethical standards and Scanning any product for plagiarism.	▪ Continuous evaluation ▪ Written report ▪ Oral discussion ▪ Presentation.

2. Assessment Tasks for Students:

- Tasks of Research Methods in Chemistry are individuality processed, and the instructor, weekly evaluate the final effort deployed by the students separately.
- The students frequently prepare a written mini report parallel with open discussion and seminars in the most of the course topics.
- The students will be divided into small groups, and each one will have a selected chemistry problem to build up research methodology, concepts, and experiments planning, end up with a research presentation.

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	*The First Report* for research process Set up, Scientific research designs and methodology. Oral presentation associated with written report.	3^{th}week	10%
2	***The Second Report***: selected problem (References Types, Bibliographies, initial research proposal, applied methodology to build up experimental part) oral presentation associated with report *(10% Oral presentation with written report, , 5% class room activity)*	7^{th} week	15 %
3	***Research Summary*** (e.g. Research article critique, participation) *(group discussion and evaluation of their work)*	Around 10^{th}– 11^{th} week	15%
4	***Final Presentation***: a selected research topic announced in 12^{th} week *(15% writing, 25% presentation)*	13^{th} week	40 %
4	**Total**		**100%**

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice:

- Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***Research Methodolgy*: a step-by-step guide for beginners** , Kumar, R.; SAGE Publications Ltd-London, 3 rd edition, 2011, ISBN 978-1-84920-300-5 ***A Short Guide to Writing About Chemistry*** Davis, H.B.; Tyson, J.F.; Pechenik, J.A. Addison-Wesley, Boston, MA. 2010, ISBN 9780205550609 ***The ACS Style Guide*** (2006), (Coghill, A.M., Garson, L.R., Eds.), American Chemical Society, Washington, DC. ISBN 9780841239999 (Available free of charge ***Write Like a Chemist***, , M.S., Stoller, F.L., Costanza-Robinson, M.S., Jones, J.K , Robinson,., Oxford University Press, Oxford, 2008.ISBN: 9780195305074.
Essential Reference Materials	NONE
Electronic Materials	IMSIU Ethical Standards **rule** https://units.imamu.edu.sa/deanships/SR/Documents/لا/الأخلاقيات%20العلمية-لائحة.pdf . • Saudi Digital Library. • Available database.
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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.
	Course Responsible	**Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Seminar**
Course Code:	**CHM 6295**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: 1 (1 Lectures, 0 Lab, 0 Tutorials)	
2. Course type ☒ Required ☐ Elective	
3. Level/year at which this course is offered: Level 4/ Year 2	
4. Pre-requisites for this course (if any): CHM 6111, CHM 6121, CHM 6131, and CHM 6141	
5. Co-requisites for this course (if any): None	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	12	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	0
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	12
Total		12

B. Course Objectives and Learning Outcomes

1. Course Description

The course covers modern research aspects related to the student's advanced research plan. The course includes conducting a participatory seminar among the program's students to present and discuss scientific ideas and train on the desired scientific debate.

This course is a supervised study in reading and doing seminar that allowing the student to work on a material not covered by any other M. Sc courses. In addition, the course enables the student to be more acquainted with some new research topics in a specific field relevant to the thesis project. A supervisor suggests the topic of the course to a qualified graduate student for M. Sc research subject.

2. Course Main Objective

- Involving students in recent research in chemistry and discussing it
- Demonstrate the ability to listen to a scientific presentation
- Gain a broader knowledge of the various subfields of chemistry.
- Gain in-depth knowledge of one topic - the research topic.

3. Course Learning Outcomes

3. A. *Inorganic Chemistry Track*

CLOs *After completion of the course, The Graduate is able*		Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To outline the relevant information of *Inorganic Chemistry* presented in technical and/or scientific journals.	K1. *Inorg*.; K2. *Inorg*.; k3. *Inorg*.; K4. *Inorg*.
1.2	To state the appropriate methods and routes in formulating a research problem relevant for research topic in *Inorganic Chemistry*.	K1. *Inorg*.; K3. *Inorg*.; K4. *Inorg*.
1.3	To list in-depth the chemical literatures survey analysis with comparing the required scientific approach covering the thesis topics.	K1. *Inorg*.; K2. *Inorg*.; K3. *Inorg*.
1.4	To recognize a critical assessment of scientific work conducted by others.	K1. *Inorg*.; K2. *Inorg*.; K3. *Inorg*.
2	**Skills:**	
2.1	To develop experience in searching and assessing current literature serving the research topic.	S1. *Inorg*.; S4. *Inorg*.
2.2	To summarize the literature survey, the applied methods and techniques used in Advanced Composite Materials analysis and relevant topics.	S1. *Inorg*.; S2. *Inorg*.; S3. *Inorg*.
2.3	To analyze and contrast the literature survey to construct own research topic.	S1. *Inorg*.; S3.*Inorg*.; S4. *Inorg*.
2.4	To evaluate a solution for a selected problem relevant to the thesis topics in Inorganic chemistry, accompanying writing of mini- Reports, operating electronic mail, and Networks in communicating with others.	*S1. Inorg.; S3. Inorg.; S4. Inorg.*
3	**Values:**	
3.1	To demonstrate scientific research, independently and collaborate with groups in relevant topics.	*V1. Inorg.; V2. Inorg.*
3.2	To use all information gained effectively, with research team in class discussions or team works, as well as independently.	*V1. Inorg.; V2. Inorg.*

3. B. *Organic Chemistry Track*

	CLOs *After completion of the course, The Graduate is able to*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To outline the relevant information of *Organic Chemistry* presented in technical and/or scientific journals.	K1. *Org*.; K2. *Org*.; k3. *Org*.; K4. *Org*.
1.2	To state the appropriate methods and routes in formulating a research problem relevant for research topic in *Organic Chemistry*.	K1. *Org*.; K3. *Org*.; K4. *Org*.
1.3	To list in-depth the chemical literatures survey analysis with comparing the required scientific approach covering the thesis topics.	K1. *Org*.; K2. *Org*.; K3. *Org*.
1.4	To recognize a critical assessment of scientific work conducted by others.	K1. *Org*.; K2. *Org*.; K3. *Org*.
2	**Skills:**	
2.1	To develop experience in searching and assessing current literature serving the research topic.	S1. *Org*.; S4. *Org*.
2.2	To summarize the literature survey, the applied methods and techniques used in Complex Structures synthesis and analysis and relevant topics in applications.	S1. *Org*.; S2. *Org*.; S3. *Org*.
2.3	To analyze and contrast the literature survey to construct own research topic.	S1. *Org*.; S3. *Org*.; S4. *Org*.
2.4	To evaluate a solution for a selected problem relevant to the thesis topics in Organic chemistry, accompanying writing of mini- Reports, operating electronic mail, and Networks in communicating with others.	*S1. Org.; S3. Org.; S4. Org.*
3	**Values:**	
3.1	To demonstrate scientific research, independently and collaborate with groups in relevant topics.	*V1. Org.; V2. Org.*
3.2	To use all information gained effectively, with research team in class discussions or team works, as well as independently.	*V1. Org.; V2. Org.*

3. C. *Analytical Chemistry Track*

	CLOs *After completion of the course, The Graduate is able to*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To outline the relevant information of ***Analytical Chemistry*** presented in technical and/or scientific journals.	K1. *Anal.*; K2. *Anal.*; k3. *Anal.*; K4. *Anal.*
1.2	To state the appropriate methods and routes in formulating a research problem relevant for research topic in ***Analytical Chemistry***.	K1. *Anal.*; K2. *Anal.*; K4. *Anal.*
1.3	To list in-depth the chemical literatures survey analysis with comparing the required scientific approach covering the thesis topics.	K1. *Anal.*; K2. *Anal.*; K3. *Anal.*
1.4	To recognize a critical assessment of scientific work conducted by others.	K1. *Anal.*; K2. *Anal.*; K3. *Anal.*
2	**Skills:**	
2.1	To develop experience in searching and assessing current literature serving the research topic.	S1. *Anal.*; S4. *Anal.*
2.2	To summarize the literature survey, the applied methods and techniques used in Environmental Chemistry, Water Pollution and relevant topics in applications in Analytical Chemistry.	S1. *Anal.*; S2. *Anal.*; S3. *Anal.*
2.3	To analyze and contrast the literature survey to construct own research topic.	S1. *Anal.*; S3. *Anal.*; S4. *Anal.*
2.4	To evaluate a solution for a selected problem relevant to the thesis topics in Analytical Chemistry, accompanying writing of mini- Reports, operating electronic mail, and Networks in communicating with others.	*S1. Anal.; S3. Anal.; S4. Anal.*
3	**Values:**	
3.1	To demonstrate scientific research, independently and collaborate with groups in relevant topics.	*V1. Anal.; V2. Anal.*
3.2	To use all information gained effectively, with research team in class discussions or team works, as well as independently.	*V1. Anal.; V2. Anal.*

3. D. *Physical Chemistry Track*

	CLOs *After completion of the course, The Graduate is able to*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To outline the relevant information of *Physical Chemistry* presented in technical and/or scientific journals.	K1. *Phy.*; K2. *Phy.*; k3. *Phy.*; K4. *Phy.*
1.2	To state the appropriate methods and routes in formulating a research problem relevant for research topic in *Physical Chemistry*.	K1. *Phy.*; K2. *Phy.*; K4. *Phy.*
1.3	To list in-depth the chemical literatures survey, analysis with comparing the required scientific approach covering the thesis topics.	K1. *Phy.*; K2. *Phy.*; K3. *Phy.*
1.4	To recognize a critical assessment of scientific work conducted by others.	K1. *Phy.*; K2. *Phy.*; K3. *Phy.*
2	**Skills:**	
2.1	To develop experience in searching and assessing current literature serving the research topic.	S1. *Phy.*; S4. *Phy.*
2.2	To summarize the literature survey, the applied methods and techniques used Thermodynamics and Materials Science and its applications in Nanomaterials, and Hybrid Materials, and relevant topics and applications.	S1. *Phy.*; S2. *Phy.* S3. *Phy.*
2.3	To analyze and contrast the literature survey to construct own research topic.	S1. *Phy.*; S3. *Phy.*; S4. *Phy.*
2.4	To evaluate a solution for a selected problem relevant to the thesis topics in Physical Chemistry, accompanying writing of mini- Reports, operating electronic mail, and Networks in communicating with others.	*S1. Phy.; S3. Phy.; S4. Phy.*
3	**Values:**	
3.1	To demonstrate scientific research, independently and collaborate with groups in relevant topics.	*V1. Phy.; V2. Phy.*
3.2	To use all information gained effectively, with research team in class discussions or team works, as well as independently.	*V1. Phy.; V2. Phy.*

C. Course Content

No	List of Topics	Contact Hours
1	Proposed title relevant for M.Sc. Project, Student' work on their own preliminary master's thesis	4
2	Attendance at least in four seminars and reporting them.	4
3	Determining a list of specified materials and the appropriate resources to read including IMSIU Ethical Standards	2
8	Students' feedback on another student's preliminary master's thesis	2
Total		**12**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

1.1. ***Inorganic Chemistry Track***

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	**To outline the relevant information of *Inorganic Chemistry* presented in technical and/or scientific journals.**	▪ One hours are weekly. ▪ Students are encouraged to make regular visits during office hours where they can ask any question about the course.	▪ Oral Discussion ▪ Participation.
1.2	**To state the appropriate methods and routes in formulating a research problem relevant for research topic in *Inorganic Chemistry*.**	▪One hours are weekly containing guidance to formulate the research problem. ▪Think and talk to conceptualize the research design with optimization.	▪ Oral Discussion ▪ Participation. ▪ Written mini-reports for evaluation.
1.3	**To list in-depth the chemical literatures survey analysis with comparing the required scientific approach covering the thesis topics.**	▪ Evaluate and discuss about chemical literatures survey analysis in open discussion	▪ Oral Discussion ▪ Participation. ▪ Mini-reports for evaluation
1.4	**To recognize a critical assessment of scientific work conducted by others.**	▪ One hours are weekly containing lectures. ▪ Open Discussion about critical assessment of scientific work conducted by others using available references online.	▪ Oral Discussion ▪ Participation. ▪ Mini-reports for evaluation
2.0	**Skills**		
2.1	**To develop experience in searching and assessing current literature serving the research topic.**	▪Lectures activity. ▪Self-study ▪ Evaluate weekly Independent developing through Group discussion	▪ Continuous evaluation- written test. ▪ Written report ▪ Oral discussion
2.2	**To summarize the literature survey, the applied methods and techniques used in *Advanced Composite Materials analysis* and relevant topics.**	▪Lectures activity. ▪ Self-study. ▪Follow up Independent development in preparing a research topic or scientific presentation.	▪ Continuous evaluation - written test. ▪ Written report ▪ Oral discussion ▪ Presentation

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
2.3	**To analyze and contrast the literature survey to construct own research topic.**	▪ Independent and group literature survey analysis	▪ Continuous evaluation ▪ Written report ▪ Oral discussion
2.4	**To evaluate a solution for a selected problem relevant to the thesis topics in Inorganic Chemistry, accompanying writing of mini- Reports, operating electronic mail, and Networks in communicating with others.**	▪ Independent and group literature survey analysis.	▪ Oral Discussion. ▪ Quizzes, and Exams. ▪ Giving marks for Oral Discussion in Lectures.
3.0	Values		
3.1	**To demonstrate scientific research, independently and collaborate with groups in relevant topics.**	▪ Brain Storms ▪ Group Discussion	▪ Continuous evaluation ▪ Written report ▪ Oral discussion Presentation
3.2	**To use all information gained effectively, with research team in class discussions or team works, as well as independently.**	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects	▪ Continuous evaluation ▪ Written report ▪ Oral discussion ▪ Presentation

1.2. ***Organic Chemistry Track***

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	**To outline the relevant information of *Organic Chemistry* presented in technical and/or scientific journals.**	▪ One hours are weekly. ▪ Students are encouraged to make regular visits during office hours where they can ask any question about the course.	▪ Oral Discussion ▪ Participation.
1.2	**To state the appropriate methods and routes in formulating a research problem relevant for research topic in *Organic Chemistry*.**	▪ One hours are weekly containing guidance to formulate the research problem. ▪ Think and talk to conceptualize the research design with optimization.	▪ Oral Discussion ▪ Participation. ▪ Written mini-reports for evaluation.
1.3	**To list in-depth the chemical literatures survey analysis with comparing the required scientific approach covering the thesis topics.**	▪ Evaluate and discuss about chemical literatures survey analysis in open discussion	▪ Oral Discussion ▪ Participation. ▪ Mini-reports for evaluation
1.4	**To recognize a critical assessment of scientific work conducted by others.**	▪ One hours are weekly containing lectures. ▪ Open Discussion about critical assessment of scientific work conducted by others using available references online.	▪ Oral Discussion ▪ Participation. ▪ Mini-reports for evaluation
2.0	**Skills**		
2.1	**To develop experience in searching and assessing current literature serving the research topic.**	▪ Lectures activity. ▪ Self-study ▪ Evaluate weekly Independent developing through Group discussion	▪ Continuous evaluation- written test. ▪ Written report ▪ Oral discussion
2.2	**To summarize the literature survey, the applied methods and techniques used in *Complex Structures synthesis and analysis* and relevant topics in applications.**	▪ Lectures activity. ▪ Self-study. ▪ Follow up Independent development in preparing a research topic or scientific presentation.	▪ Continuous evaluation - written test. ▪ Written report ▪ Oral discussion ▪ Presentation
2.3	**To analyze and contrast the literature survey to construct own research topic.**	▪ Independent and group literature survey analysis	▪ Continuous evaluation ▪ Written report

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
			▪ Oral discussion
2.4	**To evaluate a solution for a selected problem relevant to the thesis topics in Organic Chemistry, accompanying writing of mini- Reports, operating electronic mail, and Networks in communicating with others.**	▪ Independent and group literature survey analysis.	▪ Oral Discussion. ▪ Quizzes, and Exams. ▪ Giving marks for Oral Discussion in Lectures.
3.0	Values		
3.1	**To demonstrate scientific research, independently and collaborate with groups in relevant topics.**	▪ Brain Storms ▪ Group Discussion	▪ Continuous evaluation ▪ Written report ▪ Oral discussion Presentation
3.2	**To use all information gained effectively, with research team in class discussions or team works, as well as independently.**	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects	▪ Continuous evaluation ▪ Written report ▪ Oral discussion ▪ Presentation

1.3. *Analytical Chemistry Track*

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	**To outline the relevant information of *Analytical Chemistry* presented in technical and/or scientific journals.**	▪ One hours are weekly. ▪ Students are encouraged to make regular visits during office hours where they can ask any question about the course.	▪ Oral Discussion ▪ Participation.
1.2	**To state the appropriate methods and routes in formulating a research problem relevant for research topic in *Analytical Chemistry*.**	▪One hours are weekly containing guidance to formulate the research problem. ▪Think and talk to conceptualize the research design with optimization.	▪ Oral Discussion ▪ Participation. ▪ Written mini-reports for evaluation.
1.3	**To list in-depth the chemical literatures survey analysis with comparing the required scientific approach covering the thesis topics.**	▪ Evaluate and discuss about chemical literatures survey analysis in open discussion	▪ Oral Discussion ▪ Participation. ▪ Mini-reports for evaluation
1.4	**To recognize a critical assessment of scientific work conducted by others.**	▪ One hours are weekly containing lectures. ▪ Open Discussion about critical assessment of scientific work conducted by others using available references online.	▪ Oral Discussion ▪ Participation. ▪ Mini-reports for evaluation
2.0	**Skills**		
2.1	**To develop experience in searching and assessing current literature serving the research topic.**	▪Lectures activity. ▪Self-study ▪ Evaluate weekly Independent developing through Group discussion	▪ Continuous evaluation- written test. ▪ Written report ▪ Oral discussion
2.2	**To summarize the literature survey, the applied methods and techniques used in Environmental Chemistry, Water Pollution and relevant topics in applications in Analytical Chemistry.**	▪Lectures activity. ▪ Self-study. ▪Follow up Independent development in preparing a research topic or scientific presentation.	▪ Continuous evaluation - written test. ▪ Written report ▪ Oral discussion ▪ Presentation
2.3	**To analyze and contrast the literature survey to construct own research topic.**	▪ Independent and group literature survey analysis	▪ Continuous evaluation ▪ Written report

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
			▪ Oral discussion
2.4	**To evaluate a solution for a selected problem relevant to the thesis topics in Analytical Chemistry, accompanying writing of mini- Reports, operating electronic mail, and Networks in communicating with others.**	▪ Independent and group literature survey analysis.	▪ Oral Discussion. ▪ Quizzes, and Exams. ▪ Giving marks for Oral Discussion in Lectures.
3.0	Values		
3.1	**To demonstrate scientific research, independently and collaborate with groups in relevant topics.**	▪ Brain Storms ▪ Group Discussion	▪ Continuous evaluation ▪ Written report ▪ Oral discussion Presentation
3.2	**To use all information gained effectively, with research team in class discussions or team works, as well as independently.**	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects	▪ Continuous evaluation ▪ Written report ▪ Oral discussion ▪ Presentation

1.4. ***Physical Chemistry Track***

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	**To outline the relevant information of *Physical Chemistry* presented in technical and/or scientific journals.**	▪ One hours are weekly. ▪ Students are encouraged to make regular visits during office hours where they can ask any question about the course.	▪ Oral Discussion ▪ Participation.
1.2	**To state the appropriate methods and routes in formulating a research problem relevant for research topic in *Physical Chemistry*.**	▪ One hours are weekly containing guidance to formulate the research problem. ▪ Think and talk to conceptualize the research design with optimization.	▪ Oral Discussion ▪ Participation. ▪ Written mini-reports for evaluation.
1.3	**To list in-depth the chemical literatures survey, analysis with comparing the required scientific approach covering the thesis topics.**	▪ Evaluate and discuss about chemical literatures survey analysis in open discussion	▪ Oral Discussion ▪ Participation. ▪ Mini-reports for evaluation
1.4	**To recognize a critical assessment of scientific work conducted by others.**	▪ One hours are weekly containing lectures. ▪ Open Discussion about critical assessment of scientific work conducted by others using available references online.	▪ Oral Discussion ▪ Participation. ▪ Mini-reports for evaluation
2.0	**Skills**		
2.1	**To develop experience in searching and assessing current literature serving the research topic.**	▪ Lectures activity. ▪ Self-study ▪ Evaluate weekly Independent developing through Group discussion	▪ Continuous evaluation- written test. ▪ Written report ▪ Oral discussion
2.2	**To summarize the literature survey, the applied methods and techniques used Thermodynamics and Materials Science and its applications in Nanomaterials, and Hybrid Materials, and relevant topics and applications.**	▪ Lectures activity. ▪ Self-study. ▪ Follow up Independent development in preparing a research topic or scientific presentation.	▪ Continuous evaluation - written test. ▪ Written report ▪ Oral discussion ▪ Presentation
2.3	**To analyze and contrast the literature survey to construct own research topic.**	▪ Independent and group literature survey analysis	▪ Continuous evaluation ▪ Written report

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
			▪ Oral discussion
2.4	To evaluate a solution for a selected problem relevant to the thesis topics in Physical Chemistry, accompanying writing of mini- Reports, operating electronic mail, and Networks in communicating with others.	▪ Independent and group literature survey analysis.	▪ Oral Discussion. ▪ Quizzes, and Exams. ▪ Giving marks for Oral Discussion in Lectures.
3.0	Values		
3.1	To demonstrate scientific research, independently and collaborate with groups in relevant topics.	▪ Brain Storms ▪ Group Discussion	▪ Continuous evaluation ▪ Written report ▪ Oral discussion Presentation
3.2	To use all information gained effectively, with research team in class discussions or team works, as well as independently.	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects	▪ Continuous evaluation ▪ Written report ▪ Oral discussion ▪ Presentation

2. Assessment Tasks for Students

- Tasks of Seminar are individuality processed, and the instructor, weekly evaluate the final effort deployed by the students separately.
- The students frequently prepare a written mini report parallel with open discussion and seminars in the most of the course topics.

  The students will be divided into small groups, and each one will have a selected chemistry problem to build up research methodology, concepts, and experiments planning, end up with a research presentation.

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	***The First Report*** for research process Set up, Scientific research designs and methodology. Oral presentation associated with written report.	3th week	20%
2	***The Second Report***: Report on and presentation of another student's (4 times/semester), oral presentation associated with report. *(15% Oral presentation with written report, , 5% class room activity)*	7th week	20 %
3	***Research Summary*** Oral Presentation of own research approach. (e.g. Research article critique, participation) *(group discussion and evaluation of their work)*	Around 11th– 12th week	20%
4	***Final Presentation***: a selected research topic relevant for Master Program Proposal announced in 3th week *(15% writing, 25% presentation) (15% writing, 25% presentation)*	13th week	40 %
4	Total		100%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice: • **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;** • **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.** • **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.** • **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	A specified Books, journal articles and references from University Central Library and Saudi Digital Library will be delivered.
Essential Reference Materials	**None**
Electronic Materials	• Saudi Digital Library. • Available database.
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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.
	Course Responsible	**Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications (Postgraduate Degree)

Course Title:	**Thesis**
Course Code:	**CHM 6299**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: **10 (0 Lectures, 20 Lab, 0 Tutorials)**	
2. Course type ☒ Required ☐ Elective	
3. Level/year at which this course is offered: **Level 6/ Year 2**	
4. Pre-requisites for this course (if any): 1. He/she must have completed all admission requirements. (After completing the first year and with a GPA of 3.75 or above, the student has the right to submit his/her desires to choose the supervisor of the thesis project,). 2. He/she must have passed at least 50% of the academic courses (The student has the right to submit the thesis project to the department, according to the student's desire for the minor and according to the possibilities). 3. The GPA should not be less than (3.75).	
5. Co-requisites for this course (if any): **None**	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom		
2	Blended		
3	E-learning		
4	Distance learning		
5	Other	240	100 %

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	0
2	Laboratory/Studio	subject dependent
3	Seminars	subject dependent
4	Others (specify)	0
Total		240

B. Course Objectives and Learning Outcomes

1. Course Description

The presented thesis reflects the ability of the master's student to complete the chosen research assignment in a scientific and independent manner. The student's cognitive skills, which he acquired during the university studies and the theoretical part of the master's program, are refined. The course includes the compilation of published research in the field of the research plan, its study, and practical experiments that serve a research plan in order to reach the desired results of scientific publication.

2. Course Main Objective

- Application of acquired scientific knowledge to solve problems at the proposed research point
- Conducting literary studies, and a critical review of current information on the state of knowledge in the field of research
- The ability to plan or think scientifically and choose the right way to achieve the goal of the research
- Collecting, evaluating and analyzing scientific data systematically
- Demonstrate the ability to interpret and discuss findings and conclusions
- Demonstrate ability to discuss the research project
- The ability to write and present results in a scientific way
- Acquiring the skill of critical review and discussing it in a scientific manner.

3. Course Learning Outcomes

3. A. *Inorganic Chemistry Track*

CLOs	*After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To outline a good understanding of Inorganic Chemistry with sufficient background in relevant fields.	K1. *Inorg.*; K2. *Inorg.*; K3. *Inorg*; K4. *Inorg.*
1.2	To describe and carry out independent research and analysis of the obtained data, and contribute substantive work in Inorganic Chemistry.	K1. *Inorg*; K3. *Inorg*; K4. *Inorg.*
1.3	To recognize the newest progress and development in Inorganic Chemistry and related fields.	K2. *Inorg.*; K3. *Inorg.*
1.4	To record a comprehensive mastery of thesis understanding to develop, update, and present information inclusive of various or relevant topics, including the limitations of the research methods used in their work.	K1. *Inorg*; K2. *Inorg.*; K4. *Inorg.*
2	**Skills:**	
2.1	To Summarize and evaluate concepts and theories of Inorganic Chemistry and relevant topics via searching and assessing current literature.	S1. *Inorg.*; S2. *Inorg.*; K3. *Inorg.*
2.2	To create and plan a research project independently with manipulating research laboratory instruments, highly sensitive equipment, hazardous and non-hazardous materials with full capability to analyze the obtained results.	S1. *Inorg.*; S2. *Inorg.*; S3. *Inorg.*
2.3	To perform knowledge of basic lab safety and the requirements to assist in establishing a safe lab environment.	S2. *Inorg.*
2.4	To demonstrate creative and innovative approaches to student research thesis, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.	S1. *Inorg.*; S2.*Inorg.*; S3. *Inorg.*; S4. *Inorg.*
3	**Values:**	
3.1	To show ethical issues and responsibilities related to professionalism, data analysis and treatment.	V1. *Inorg.*; V2. *Inorg.*
3.2	To appraise effectively the collaboration and inter-professionalism in Lab. discussions or team works, as well as independently.	V1. *Inorg.*; V2. *Inorg.*

3. B. ***Organic Chemistry Track***

	CLOs *After completion of the course, The Graduate is able*	**Aligned PLOs**
1	**Knowledge and Understanding**	
1.1	To outline a good understanding of Organic Chemistry with sufficient background in relevant fields.	K1. *Org.*; K2. *Org.*; K3. *Org.*; K4. *Org.*
1.2	To describe and carry out independent research with a Full elucidation of Chemical Structures or methods and contribute substantive work in Organic Chemistry.	K1. *Org.*; K2. *Org.*; K3. *Org.*; K4. *Org*
1.3	To define the newest progress and development Organic Chemistry and related fields.	K2. *Org.*; K3. *Org.*
1.4	To record a comprehensive mastery of thesis understanding of Organic Chemistry to develop, update, and present information inclusive of various or relevant topics, including the limitations of the research methods used in their work.	K1. *Org.*; K2. *Org.*; K4. *Org.*
2	**Skills:**	
2.1	To Summarize and evaluate Synthetic Methods, Stereochemistry, Functional Groups, and reactivity relationships concepts of Organic Chemistry and relevant topics via searching and assessing current literature.	S1. *Org.*; S2. *Org.*; S4. *Org.*
2.2	To create and plan a research project independently with manipulating research laboratory instruments, highly sensitive equipment, hazardous and non-hazardous materials with full capability to analyze the obtained results.	S1. *Org.*; S2. *Org.*; S3. *Org.*
2.3	To perform knowledge of basic lab safety and the requirements to assist in establishing a safe lab environment.	S2. *Org.*
2.4	To demonstrate creative and innovative approaches to student research thesis, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.	S1. *Org.*; S2. *Org.*; S3. *Org.*; S4. *Org.*
3	**Values:**	
3.1	To show ethical issues and responsibilities related to professionalism, data analysis and treatment.	V1. *Org.*; V2. *Org.*
3.3	To appraise effectively the collaboration and inter-professionalism in Lab. discussions or team works, as well as independently.	V1. *Org.*; V2. *Org.*

3. C. *Analytical Chemistry Track*

	CLOs *After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To outline a good understanding of Analytical Chemistry principles and concepts with sufficient background in relevant fields.	K1. *Anal.*; K2. *Anal.*; K3. *Anal.*; K4. *Anal.*
1.2	To describe and carry out independent research with an understanding of pollutants, Modern Analytical Atomic Spectroscopy Methods and contribute substantive work in Analytical Chemistry.	K1. *Anal.*; K2. *Anal.*; K3. *Anal.*; K4. *Anal.*
1.3	To define the newest progress and development Analytical Chemistry and related fields.	K2. *Anal.*; K3. *Anal.*
1.4	To record a comprehensive mastery of thesis understanding of Analytical Chemistry to develop, update, and present information inclusive of various or relevant topics, including the limitations of the research methods used in their work.	K1. *Anal.*; K2. *Anal.*; K3. *Anal.*; K4. *Anal.*
2	**Skills:**	
2.1	To Summarize and evaluate Modern Analytical Atomic Spectroscopy Methods, and Electrochemical analytical techniques in Environmental Chemistry and Water Pollution and relevant topics via searching and assessing current literature.	S1. *Anal.*; S2. *Anal.*; S3. *Anal.*
2.2	To create and plan a research project independently with manipulating research laboratory instruments, highly sensitive equipment, hazardous and non-hazardous materials with full capability to analyze the obtained results.	S1. *Anal.*; S2. *Anal.*; S4. *Anal.*
2.3	To perform knowledge of basic lab safety and the requirements to assist in establishing a safe lab environment.	S2. *Anal.*
2.4	To demonstrate creative and innovative approaches to student research thesis, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.	S1. *Anal.*; S2. *Anal.*; S3. *Anal.*; S4. *Anal.*
3	**Values:**	
3.1	To show ethical issues and responsibilities related to professionalism, data analysis and treatment.	V1. *Anal.*; V2. *Anal.*
3.3	To appraise effectively the collaboration and inter-professionalism in Lab. discussions or team works, as well as independently.	V1. *Anal.*; V2. *Anal.*

3. D. ***Physical Chemistry Track***

	CLOs *After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To outline a good understanding of Physical Chemistry principles, concepts and theories with sufficient background in relevant fields.	K1. *Phy.*; K2. *Phy.*; K3. *Phy.*; K4. *Phy..*
1.2	To describe and carry out independent research with an understanding of thermodynamics and kinetics for materials and materials and contribute substantive work in Physical Chemistry.	K1. *Phy.*; K2. *Phy.*; K3. *Phy.*; K4. *Phy.*
1.3	To define the newest progress and development Physical Chemistry and related fields.	K2. *Phy.*; K3. *Phy.*
1.4	To record a comprehensive mastery of thesis understanding of Physical Chemistry to develop, update, and present information inclusive of various or relevant topics, including the limitations of the research methods used in their work.	K1. *Phy.*; K2. *Phy.*; K3. *Phy.*; K4. *Phy.*
2	**Skills:**	
2.1	To Summarize and evaluate Kinetics, Thermodynamics and Materials Science and its applications in Nanomaterials, and Hybrid Materials, and relevant topics via searching and assessing current literature.	S1. *Phy.*; S2. *Phy.*; S3. *Phy.*
2.2	To create and plan a research project independently with manipulating research laboratory instruments, highly sensitive equipment, hazardous and non-hazardous materials with full capability to analyze the obtained results.	S1. *Phy.*; S2. *Phy.*; S4. *Phy.*
2.3	To perform knowledge of basic lab safety and the requirements to assist in establishing a safe lab environment.	S2. *Phy.*
2.4	To demonstrate creative and innovative approaches to student research thesis, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.	S1. *Phy.*; S2. *Phy.*; S3. *Phy.*; S4. *Phy.*
3	**Values:**	
3.1	To show ethical issues and responsibilities related to professionalism, data analysis and treatment.	V1. *Phy.*; V2. *Phy.*
3.3	To appraise effectively the collaboration and inter-professionalism in Lab. discussions or team works, as well as independently.	V1. *Phy.*; V2. *Phy.*

C. Course Content

No	List of Topics	Contact Hours
1	***Subject dependent*** • The thesis contents provide a comprehensive foundation across the required breadth of specific subjects for a degree in Chemistry at Masters level. • Literature Survey: The published literature is one of the most potent tools of the thesis research has available. • Conduct of research • Written Report and Oral and Presentation of the research progress. • Written work: Written work of the thesis.	240
	Total	**240**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

1.1. *Inorganic Chemistry Track*

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	To outline a good understanding of Inorganic Chemistry with sufficient background in relevant fields.	▪ Follow up-to To Demonstrate mastery of appropriate research techniques and procedures. ▪ Formulate Discussion on the basis of observations, obtain and analyze data to test	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation
1.2	To describe and carry out independent research and analysis of the obtained data, and contribute substantive work in Inorganic Chemistry.	▪ Precisely describe all research results and forms of scientific investigation used in written thesis.	▪ Referees reports on written thesis. ▪ Defense committee evaluation
1.3	To recognize the newest progress and development in Inorganic Chemistry and related fields.	▪ Summarize existing literature, interpret and compare within existing research findings.	▪ Referees reports on written thesis. ▪ Defense committee evaluation
1.4	To record a comprehensive mastery of thesis understanding of Inorganic Chemistry to develop, update, and present information inclusive of various or relevant topics, including the limitations of the research methods used in their work.	▪ Written Thesis including, practical experimental documents describing methods, data, and limitations of research, and results that are suitable for eventual Defense.	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation.
2.0	**Skills**		
2.1	To Summarize and evaluate concepts and theories of Inorganic Chemistry and relevant topics via searching and assessing current literature.	▪ Independent developing under the guidance of the supervisor through discussion weekly.	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation.
2.2	To create and plan a research project independently with manipulating research laboratory instruments, highly sensitive equipment, hazardous and non-hazardous materials with full capability to analyze the obtained results.	▪ Independent developing in preparing a research topic based on obtained observations	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation.
2.3	To perform knowledge of basic lab safety and the requirements to assist in establishing a safe lab environment.	▪ Scientific evaluation and discussion in obtained results and difficulties faced.	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation.
2.4	To demonstrate creative and innovative approaches to student research thesis, accompanying writing of mini- Reports,	▪ Outlines problems faced during research work for discussion with a per	▪ Supervisor Evaluation.

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
	operating electronic mail, and Network in communicating with others.	research group or others.	▪ Referees reports on written thesis. ▪ Defense committee evaluation.
3.0	**Values**		
3.1	To show ethical issues and responsibilities related to professionalism, data analysis and treatment.	▪ Written thesis containing the research results. ▪ Oral presentation of the thesis.	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation
3.2	To appraise effectively the collaboration and inter-professionalism in Lab. discussions or team works, as well as independently.	▪ Written thesis containing the research results. ▪ Oral Discussion of the thesis.	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation

1.2. *Organic Chemistry Track*

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and Understanding		
1.1	To outline a good understanding of Organic Chemistry with sufficient background in relevant fields.	▪ Follow up-to To Demonstrate mastery of appropriate research techniques and procedures. ▪ Formulate Discussion on the basis of observations, obtain and analyze data to test	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation
1.2	To describe and carry out independent research with a Full elucidation of Chemical Structures or methods and contribute substantive work in Organic Chemistry.	▪ Precisely describe all research results and forms of scientific investigation used in written thesis.	▪ Referees reports on written thesis. ▪ Defense committee evaluation
1.3	To define the newest progress and development Organic Chemistry and related fields.	▪ Summarize existing literature, interpret and compare within existing research findings.	▪ Referees reports on written thesis. ▪ Defense committee evaluation
1.4	To record a comprehensive mastery of thesis understanding of Organic Chemistry to develop, update, and present information inclusive of various or relevant topics, including the limitations of the research methods used in their work.	▪ Written Thesis including, practical experimental documents describing methods, data, and limitations of research, and results that are suitable for eventual Defense.	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation.
2.0	Skills		
2.1	To Summarize and evaluate Synthetic Methods, Stereochemistry, Functional Groups, and reactivity relationships concepts of Organic Chemistry and relevant topics via searching and assessing current literature.	▪ Independent developing under the guidance of the supervisor through discussion weekly.	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation.
2.2	To create and plan a research project independently with manipulating research laboratory instruments, highly sensitive equipment, hazardous and non-hazardous materials with full capability to analyze the obtained results.	▪ Independent developing in preparing a research topic based on obtained observations	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation.
2.3	To perform knowledge of basic lab safety and the requirements to assist in establishing a safe lab environment.	▪ Scientific evaluation and discussion in obtained results and difficulties faced.	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation.
2.4	To demonstrate creative and innovative approaches to student research thesis, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.	▪ Outlines problems faced during research work for discussion with a per research group or others.	▪ Supervisor Evaluation. ▪ Referees reports on written thesis.

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
			▪ Defense committee evaluation.
3.0	**Values**		
3.1	To show ethical issues and responsibilities related to professionalism, data analysis and treatment.	▪ Written thesis containing the research results. ▪ Oral presentation of the thesis.	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation
3.2	To appraise effectively the collaboration and inter-professionalism in Lab. discussions or team works, as well as independently.	▪ Written thesis containing the research results. ▪ Oral Discussion of the thesis.	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation

1.3. *Analytical Chemistry Track*

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	To outline a good understanding of Analytical Chemistry principles and concepts with sufficient background in relevant fields.	▪ Follow up-to To Demonstrate mastery of appropriate research techniques and procedures. ▪ Formulate Discussion on the basis of observations, obtain and analyze data to test	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation
1.2	To describe and carry out independent research with an understanding of pollutants, Modern Analytical Atomic Spectroscopy Methods and contribute substantive work in Analytical Chemistry.	▪ Precisely describe all research results and forms of scientific investigation used in written thesis.	▪ Referees reports on written thesis. ▪ Defense committee evaluation
1.3	To define the newest progress and development Analytical Chemistry and related fields.	▪ Summarize existing literature, interpret and compare within existing research findings.	▪ Referees reports on written thesis. ▪ Defense committee evaluation
1.4	To record a comprehensive mastery of thesis understanding of Analytical Chemistry to develop, update, and present information inclusive of various or relevant topics, including the limitations of the research methods used in their work.	▪ Written Thesis including, practical experimental documents describing methods, data, and limitations of research, and results that are suitable for eventual Defense.	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation.
2.0	**Skills**		
2.1	To Summarize and evaluate Modern Analytical Atomic Spectroscopy Methods, and Electrochemical analytical techniques in Environmental Chemistry and Water Pollution and relevant topics via searching and assessing current literature.	▪ Independent developing under the guidance of the supervisor through discussion weekly.	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation.
2.2	To create and plan a research project independently with manipulating research laboratory instruments, highly sensitive equipment, hazardous and non-hazardous materials with full capability to analyze the obtained results.	▪ Independent developing in preparing a research topic based on obtained observations	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation.
2.3	To perform knowledge of basic lab safety and the requirements to assist in establishing a safe lab environment.	▪ Scientific evaluation and discussion in obtained results and difficulties faced.	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation.
2.4	To demonstrate creative and innovative approaches to student research thesis, accompanying writing of mini- Reports,	▪ Outlines problems faced during research work for discussion with a per	▪ Supervisor Evaluation.

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
	operating electronic mail, and Network in communicating with others.	research group or others.	▪ Referees reports on written thesis. ▪ Defense committee evaluation.
3.0	**Values**		
3.1	To show ethical issues and responsibilities related to professionalism, data analysis and treatment.	▪ Written thesis containing the research results. ▪ Oral presentation of the thesis.	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation
3.2	To appraise effectively the collaboration and inter-professionalism in Lab. discussions or team works, as well as independently.	▪ Written thesis containing the research results. ▪ Oral Discussion of the thesis.	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation

1.4. *Physical Chemistry Track*

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	To outline a good understanding of Physical Chemistry principles, concepts and theories with sufficient background in relevant fields.	▪ Follow up-to To Demonstrate mastery of appropriate research techniques and procedures. ▪ Formulate Discussion on the basis of observations, obtain and analyze data to test	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation
1.2	To describe and carry out independent research with an understanding of thermodynamics and kinetics for materials and materials and contribute substantive work in Physical Chemistry.	▪ Precisely describe all research results and forms of scientific investigation used in written thesis.	▪ Referees reports on written thesis. ▪ Defense committee evaluation
1.3	To define the newest progress and development Physical Chemistry and related fields.	▪ Summarize existing literature, interpret and compare within existing research findings.	▪ Referees reports on written thesis. ▪ Defense committee evaluation
1.4	To record a comprehensive mastery of thesis understanding of Physical Chemistry to develop, update, and present information inclusive of various or relevant topics, including the limitations of the research methods used in their work.	▪ Written Thesis including, practical experimental documents describing methods, data, and limitations of research, and results that are suitable for eventual Defense.	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation.
2.0	**Skills**		
2.1	To Summarize and evaluate Kinetics, Thermodynamics and Materials Science and its applications in Nanomaterials, and Hybrid Materials, and relevant topics via searching and assessing current literature.	▪ Independent developing under the guidance of the supervisor through discussion weekly.	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation.
2.2	To create and plan a research project independently with manipulating research laboratory instruments, highly sensitive equipment, hazardous and non-hazardous materials with full capability to analyze the obtained results.	▪ Independent developing in preparing a research topic based on obtained observations	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation.
2.3	To perform knowledge of basic lab safety and the requirements to assist in establishing a safe lab environment.	▪ Scientific evaluation and discussion in obtained results and difficulties faced.	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation.
2.4	To demonstrate creative and innovative approaches to student research thesis, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.	▪ Outlines problems faced during research work for discussion with a per research group or others.	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation.

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
3.0	**Values**		
3.1	To show ethical issues and responsibilities related to professionalism, data analysis and treatment.	▪ Written thesis containing the research results. ▪ Oral presentation of the thesis.	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation
3.2	To appraise effectively the collaboration and inter-professionalism in Lab. discussions or team works, as well as independently.	▪ Written thesis containing the research results. ▪ Oral Discussion of the thesis.	▪ Supervisor Evaluation. ▪ Referees reports on written thesis. ▪ Defense committee evaluation

2. Assessment Tasks for Students:

- **Tasks of the thesis are individuality processed, and the supervisor, weekly evaluate the effort deployed by the student.**
- **The students frequently prepare a written report parallel with open discussion with the supervisor to evaluate the work progress.**
- **Bi-annual report clarifying the thesis progress, difficulties, the predicted progress, before the end of each semester, submitted to the supervisor.**
- **Written work: Written work consists of the thesis, attention is paid to the following points:**
  - **Clarity: Well written of the thesis.**
  - **Technical merit: Clarify the scope and limitations of the work undertaken.**
  - **Literature awareness; the work presented in the thesis should be set in context by adequate references.**
- **Conduct of Research Thesis: Activity and capability of the student for dealing with instruments and analyzing the obtained results will be evaluated in thesis defense.**
- **Oral presentations: will be evaluated in thesis defense.**

The Written thesis and Defense committee evaluation will be the *Assessment Methods (*Assessment *procedures for defence and approval of the thesis)*.

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Written thesis	Around 7th of the semester CGC*	Assessment procedures for defense and approval of the thesis**
2	Public Presentation of the dissertation	Around 13th of the semester	

***CGC**

a) The validity of the thesis for discussion based on the supervisor's report.
b) The master's student must pass all the courses of the program.
c) Compliance with the provisions of **Article 36-page 27** of the Executive Regulations of Imam University.

****Assessment *procedures for defence and approval of the thesis***

1) All the Discussion/Defense members submitted to the head of the department within one week of the discussion date, a signed report including one of the following recommendations:

a. ***Acceptance*** (Excellent, Good) of the thesis **and *recommendation to award*** the degree.

b. ***Acceptance*** of the thesis **(**Satisfactory, Sufficient), ***with some modifications, without discussing*** it again and authorizing one of the members to recommend granting the degree after making sure that these amendments have been taken within time, not exceed three months from the date of the discussion, and the University Council may make an exception.

c. ***Completing the deficiencies*** **(**Satisfactory, Sufficient), in the thesis and ***re-discussing them during the period determined by the Council of Graduate Studies*** based on the recommendation of the relevant department council, provided that it does **not exceed one year from the date of the discussion.**

d. ***Not accepting the thesis*****.(** Insufficient**)**

2) Each member of the Discussion committee has the right to present his/her point of view or opinions Reservations in a detailed report to each department head and the dean of graduate studies within a period not exceeding Two weeks from the date of the discussion.

Criteria for evaluation of the thesis

Guidelines for Evaluation of Master of Science in Chemistry Thesis and Awarding Marks:

1. Independent Scientific Thinking/Originality: it might be by Evaluation of the following:

- The Significant independent contribution of the student to the outcome of the thesis,
- Demonstration of any Scientific Originality in the thesis or any new ideas or established ideas by a new approach.
- The novelty and importance of the obtained results and conclusion.

2. General Scientific Competence: it might be by Evaluation of the following:

- The familiarity of the student with the literature on the subject on the thesis.
- The aims of the thesis is clearly formulated
- The discussion and methods as well techniques are discussed properly
- The literature and methods used are adopted for the subject of the thesis.
- The research as well the context of the thesis have been carried out and written Carefully.

3. Methodological Competence: it might be by Evaluation of the following:

- The knowledge, understanding, and comprehension of the student of techniques, equipment, laboratory experiments, and precautions to be provided.
- The usefulness of applying the methods, techniques, and tools for future studies and work.

4. Logical Coherence and Quality of Presentation:

- The logic and appropriate structure and style of the thesis.
- The clarification of the results and conclusion during the presentation
- The response and answering of the questions at the end of the presentation.
- The formal requirements for literature (sources), tables, and experimental details match the standard of writing the thesis according to IMSIU requirements.
- The scientific and language of the thesis is correct and comprehensive.

5. Work Process: from the previous items, the evaluator can determine the following:

- The student has done the research thesis with dedication and care.
- The student has acquired the necessary knowledge from doing research and reading the literature, the research has been done and written independently.

✓ **The thesis and the presentation are graded on a 1-5 scale:**

1.Insufficient
2.Sufficient
3.Satisfactory
4.Good
5.Excellent

A separate sheet for the Thesis Evaluation will be attached, describing the Thesis Evaluation RUBRIC.

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice: • Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support; • The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties. • Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website. • A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	Subject dependent
Essential Reference Materials	Subject dependent
Electronic Materials	Subject dependent
Other Learning Materials	Subject dependent

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	Laboratories are equipped with appropriate instruments, tools, and chemicals with good safety precautions and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	None
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	Software in Chemistry relevant for the subject, Workstations for Molecular Dynamics.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching And assessment	▪ Students ▪ Peer Reviewer (Defense Committee) ▪ Program Leader	▪ Written Thesis ▪ surveys, ▪ Collective Defense Reports
Extent of achievement of course learning outcomes	▪ Program Leader, ▪ Peer reviewer (Defense Committee) ▪ Students ▪ Employers ▪ Graduates	▪ Surveys, ▪ Collective Defense Reports
Quality of learning resources	▪ Students ▪ Faculty (Academic Advisory-GCC) ▪ Program Leader ▪ Employers ▪ Graduates	▪ Surveys, ▪ Collective Defense Reports

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Advanced Environmental Chemistry**
Course Code:	**CHM 6234**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: **5 (5 Lectures, 0 Lab, 0 Tutorials)**	
2. Course type	
☐ Required	☒ Elective
3. Level/year at which this course is offered: **Level 4/Year 2**	
4. Pre-requisites for this course (if any): **Advanced Analytical Chemistry - CHM 6131**	
5. Co-requisites for this course (if any): **None**	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

This course describes fundamentals and advanced topics of Environmental Chemistry. The course covers the pollutants in the major components of the environment. Topics that deal with the hydrosphere such as Contaminant behavior in the aquatic environment, Water quality parameters, drinking water treatment methods, modern aspects of wastewater treatment are deeply covered in addition to air and soil pollution. The interaction of energy and the environment was covered with special emphasis on petroleum and petroleum industry pollutants in addition to renewable energy sources. Hazardous materials and toxicants and their impacts on the environment were outlined in the toxicological chemistry and ecotoxicology unit.

2. Course Main Objective

At the end of the course, the students will be able to:

- **Recognize the basic Principles of Contaminant behavior in the aquatic system and the fate of pollutants.**
- **Outline and determine the drinking water parameters.**
- **Recognize and describe the Drinking Water Treatment techniques and the waste water treatment methods.**
- **Understand the nature and behavior of the soil and air contaminants.**
- **Develop awareness of the relation and impact of the petroleum energy on the environment and to suggest renewable energy sources.**
- **Specify the toxicants and hazards with serious influence on the environment.**

3. Course Learning Outcomes

CLOs *After completion of the course, The Graduate is able*		Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To list the methods for the analysis of xenobiotic substances in environmental samples.	K1. *Anal.*; K2. *Anal.*; K4. Anal.
1.2	To outline Aquatic Chemistry Science and Water Pollution.	K2. *Anal.*; K4. *Anal.*
1.3	To state priority environmental contaminants such as selected heavy metals and dioxins.	K2. *Anal.*; K3. *Anal.*; K4. *Anal.*
1.4	To define Water Quality Parameters and Toxicological Chemistry and Ecotoxicology.	K2. *Anal.*; K4. *Anal.*
2	**Skills:**	
2.1	To summarize important chemical reactions and their mechanisms in the atmosphere and the Aquatic Environment causing Pollution.	S1. *Anal.*; S2. *Anal.*
2.2	To develop an experimental setup for analysis of various environmental samples solids or liquids.	S2. *Anal.*; S3. *Anal.*
2.3	To evaluate the nature and behavior of the soil and air contaminants.	S1. *Anal.*; S2. *Anal.*; S3. *Anal.*
2.4	To create different environmental analytical techniques and their applications, accompanying writing of mini-Reports, operating electronic mail, and networking in communicating with others.	S1. *Anal.*; S3. *Anal.* S4. *Anal.*
3	**Values:**	
3.1	To show a scientific presentation, research, and integrating with a research group, to acquire, analyze, and exchange information..	V1. *Anal.*
3.2	To use his/her ability to effective collaboration and inter-professionalism in team work, and make decisions, develop knowledge, and enhance society's quality as well as independently.	V1. *Anal.*; V2. *Anal.*

C. Course Content

No	List of Topics	Contact Hours
1	***Principles of Contaminant behavior in the aquatic environment:*** The Behavior of Contaminants in Natural Waters, Important Properties of Pollutants, Important Properties of Water and Soil, The Fates of Different Pollutants, Processes That Remove Pollutants from Water, Transport Processes, Major Contaminant Groups and Their Natural Pathways for Removal from Water.	**10**
2	***Water quality parameters:*** pH and temperature, Oxidation-Reduction (Redox) Potential, Carbon Dioxide, Bicarbonate, and Carbonate, Acidity and Alkalinity, Total Hardness, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD), Total Nitrogen, Sulfide, Phosphorus, Metals in Water, Total, Suspended, and Dissolved solids (TSS and TDS).	**8**
3	***Drinking Water Treatment methods:*** Drinking Water Standards, Basic Drinking Water Treatment methods, Disinfection Byproducts and Disinfection Residuals, Strategies for Controlling Disinfection Byproducts, chlorine and related disinfection methods, Ozone Disinfection Treatment, Potassium Permanganate, Peroxone (Ozone + Hydrogen Peroxide), Ultraviolet (UV) Disinfection Treatment, Memberane Filtration Water Treatment.	**8**
4	***Modern aspects of wastewater treatment:*** Waste water Management, Hazardous and Biomedical Waste Management, Environmental Biotechnology. Wetlands- concept, classification, importance, uses and threats to the wetlands.	**8**
5	***Air pollution:*** Gaseous Inorganic and Organic Air Pollutants, Air and Gas Analysis, (emission of NOX gases), Particulate Materials in Air, Photochemical Smog.	**6**
6	***Soil pollution:*** Source, Soil analysis, Fertility of solid and effect of pollution on it, water binding capacity of the soil, Organic fertilizers and their long term effect on soil quality	**6**
7	***Energy and the Environment:*** General Characteristics of Petroleum, Petroleum Releases to the Subsurface, Formation of Petroleum Contamination Plumes, Renewable Energy, Nuclear Fission and Fusions Power.	**7**
8	***Toxicological Chemistry and Ecotoxicology:*** Environmental Chemistry of Hazardous Wastes, Toxicological Chemistry (Nature of Toxicants and Biochemical Transformations), Toxic Elements and Organic Compounds, Analysis of Chlorinated Organic Compounds in Fatty-Food, Analysis of Xenobiotic Substances in Environmental Samples, Industrial Waste Management and Treatments.	**7**
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
1.0	**Knowledge and Understanding**		
1.1	**To list the methods for the analysis of xenobiotic substances in environmental samples.**	▪ Five hours/week lectures. ▪ Self-study ● Homework	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion ▪ Participation.
1.2	**To outline Aquatic Chemistry Science and Water Pollution.**	▪ Five hours/week lectures. ▪ Think, to justify the aquatic chemistry science and water pollution, using available references (SDL) online. ▪ Open discussion..	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.3	**To state priority environmental contaminants such as selected heavy metals and dioxins.**	▪ Five hours/ week lectures. ▪ Open Discussion with mini-reports to justify priority environmental contaminants in KSA using available references (SDL) online.	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.4	**To define Water Quality Parameters and Toxicological Chemistry and Ecotoxicology.**	▪ Five hours/week lectures. ▪ Group Discussion using available references (SDL)	▪ Assignments ▪ Open Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
2.0	**Skills**		
2.1	**To summarize important chemical reactions and their mechanisms in the atmosphere and the Aquatic Environment causing Pollution.**	▪ Lectures activity ▪ Self-study. ▪ Think, and discuss in details important chemical reactions in environment.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation ▪ Mini -seminar.
2.2	**To develop an experimental setup for analysis of various environmental samples solids or liquids.**	▪ Practice some examples for experimental setup for environmental analysis. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion ▪ Short Quizzes.
2.3	**To evaluate the nature and behavior of the soil and air contaminants.**	▪ Lectures ▪ Oral Discussions. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion.

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
			▪ Participation.
2.4	**To create different environmental analytical techniques and their applications, accompanying writing of mini-Reports, operating electronic mail, and networking in communicating with others.**	▪ Group Discussion and Assignments ▪ Launch several examples of obtained results from different environmental analytical techniques used to study, which will require 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**		
3.1	**To show a scientific presentation, research, and integrating with a research group, to acquire, analyze, and exchange information.**	▪ Brainstorming. ▪ Exercises ▪ Group Discussion. ▪ Team work.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	**To use his/her ability to effective collaboration and inter-professionalism in teamwork, and make decisions, develop knowledge, and enhance society's quality as well as independently**	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	**Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)**	**weekly**	**30 %**
2	**Midterm Exam**	**7th week**	**30 %**
3	**Final Exam**	**13th week**	**40 %**
4	**Total**		**100%**

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice: • Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support; • The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties. • Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website. • A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***Environmental Chemistry: A global perspective***, Vanloon, G. W.; Duffy, S. J., 3rd Edition, Oxford University Press, 2010. ISBN: 978-0199228867. ***Environmental Chemistry,*** Baird, C.; Cann, M., 5th Edition, W. H. Freeman, 2012.ISBN-13: 978-1429277044. ***Principles of Environmental Chemistry,*** Giard, J.E., 3rd Edition, Jones& Bartlett Learning, 2013, ISBN-13: 978-1449693527.
Essential Reference Materials	**NONE**
Electronic Materials	• Environmental Science & Technology • Science of the Total Environment • Environmental Toxicology and Chemistry, • Journal of Atmospheric Chemistry. • Saudi Digital Library
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites.

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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.
	Course Responsible	**Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Analytical Separation Methods**
Course Code:	**CHM 6133**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: **5 (5 Lectures, 0 Lab, 0 Tutorials)**	
2. Course type ☐ Required ☒ Elective	
3. Level/year at which this course is offered: **Level 3/Year 1**	
4. Pre-requisites for this course (if any): **Advanced Analytical Chemistry - CHM 6131**	
5. Co-requisites for this course (if any): **None**	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

The course will focus mainly on the sophisticated separation techniques involved in chemistry. The basic principles of the chromatographic theory will be covered. Gas Chromatography and High-Performance Liquid chromatography instrumentation, columns and applications are described in details. The theory, principles and applications of mass spectrometry and the application of it as a detector for gas and HPLC are described, in addition to Supercritical Fluid Chromatography and its applications.

2. Course Main Objective

- Familiarize with the fundamental principles of the chromatographic theory.
- Recognize the basic principles and instrumentation of gas and high-performance liquid chromatography.
- Specify the optimum conditions for separation of analytes.
- Understand the fundamentals of mass spectrometry technique.
- Be familiar with interfacing between GC and HPLC and mass spectrometer as a detector.
- Identify the basic principles of Supercritical Fluid Chromatography and its applications.

3. Course Learning Outcomes

	CLOs *After completion of the course, The Graduate is able to*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To list the principles and Chromatography theory for Modern Analytical Methods of Separation.	K1. *Anal.*; K2. *Anal.*; K4. *Anal.*
1.2	To recognize basic principles and instrumentation of gas and High-Performance Liquid Chromatography.	K2. *Anal.*; K3. *Anal.*; K4. *Anal.*
1.3	To define the strengths and limitations of different separation techniques	K1. *Anal.*; K2. *Anal.*;
1.4	To state the basic principles of Supercritical Fluid Chromatography and its applications.	K1. *Anal.*; K2. *Anal.*; K4. *Anal.*
2	**Skills:**	
2.1	To analyze data and interpret results for complex samples with different matrix constituents.	S1. *Anal.*; S2. *Anal.*; S3. Anal.
2.2	To design experimental setup for separation of compounds with different chemical properties	S2. *Anal.*; S3. *Anal.*
2.3	To justify the selection of proper analytical separation techniques for various samples to support a reasonable arguments	S1. *Anal.*; S2. *Anal.*
2.4	To interpret the used analytical separation techniques and their applications, that accompany the writing of mini- Reports, operating electronic mail, and networking in communicating with others.	S1. *Anal.*; S3. *Anal.* S4. *Anal.*
3	**Values:**	
3.1	To demonstrate a scientific presentation independently and integrate with a collaborated group to acquire, analyze, and communicate information.	V1. *Anal.*
3.2	To show his/her ability to the effectively collaboration and inter-professionalism in class discussions or team works, as well as independently.	V1. *Anal.*; V2. *Anal.*

C. Course Content

No	List of Topics	Contact Hours
1	***Chromatographic Theory:*** The Theoretical Plate Model of Chromatography, The Rate Theory of Chromatography, Retention and equilibrium in Chromatography, Detection and quantification.	**10**
2	***Gas Chromatography (GC):*** Introduction to instrumentation and operation of GC. Gas –solid chromatography, Instrumentation, Sample preparation and introduction by pyrolysis, Detectors of GC, two dimensional GC, Head space analysis, Purge and trap unit connected to GC.	**10**
3	***High Performance Liquid chromatography:*** Introduction to instrumentation and operation of HPLC, Liquid-Liquid Chromatography, Chiral Chromatography, Ion exchange Chromatography: with conductivity suppression, Ion Pairing chromatography, Size exclusion Chromatography: Gel filtration and permeation chromatography**.**	**10**
4	***Mass spectrometry:*** Mass spectrometry, Sample introduction, Methods of ionization: Electron ionization, Chemical ionization, atmospheric pressure photo ionization and field ionization, Electrospray ionization, Matrix-assisted laser desorption ionization (MALDI), Fast-atom bombardment (FAB) ionization, Ion bombardment or secondary ion mass spectrometry (SIMS), Field desorption (FD) ionization, Plasma desorption (PD) ionization, Mass analyzer: Quadruple mass filter and Time-of-flight (linear and reflection, Ion Trap.	**15**
5	***Chromatographic- Mass spectrometry:*** Application of MS as a detector for GC and HPLC. Connection of GC-MS, Connection of LC-MSS, Tandem mass spectrometry (MS/MS***.***	**7**
6	***Supercritical Fluid Chromatography (SFC):*** Supercritical Fluids as Mobile Phase, Instrumentation in SFC, SFC in Chromatographic techniques, Applications of SFC.	**8**
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
1.0	**Knowledge and Understanding**		
1.1	To list the principles and Chromatography theory for Modern Analytical Methods of Separation.	▪ Five hours/week lectures. ▪ Self-study • Homework	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion ▪ Participation.
1.2	To recognize basic principles and instrumentation of gas and High-Performance Liquid Chromatography.	▪ Five hours/week lectures. ▪ Think to justify the instrumentation of Gas and High-Performance Liquid Chromatography principles using available references (SDL) online. Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.3	To define the strengths and limitations of different separation techniques	▪ Five hours/week lectures. ▪ Group Discussion with mini-reports to justify strengths and limitations of different separation techniques using available references (SDL) online. ▪ Open Discussion.	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.4	To state the basic principles of Supercritical Fluid Chromatography and its applications.	▪ Five hours/week lectures. ▪ Group Discussion using available references (SDL).	▪ Assignments ▪ Open Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
2.0	**Skills**		
2.1	To analyze data and interpret results for complex samples with different matrix constituents.	▪ Lectures. activity ▪ Self-study. ▪ Deep discussion on analyzing and interpreting results of different matrices used.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation ▪ Mini -seminar.
2.2	To design experimental setup for separation of compounds with different chemical properties	▪ Practice some examples for experimental setup for analytical separation of specific mixtures. ▪ Brainstorming. ▪ Self-study.	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion ▪ Short Quizzes.

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
2.3	To justify the selection of proper analytical separation techniques for various samples to support a reasonable arrguments	▪ Lectures ▪ Oral Discussions. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion. ▪ Participation.
2.4	To interpret the used analytical separation techniques and their applications, that accompany the writing of mini- Reports, operating electronic mail, and networking in communicating with others.	▪ Group Discussion and Assignments. ▪ Suggest several examples of chemical separation techniques used to study, which will require 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		
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.	▪ Brain Storms Exercises ▪ Group Discussion	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments
3.2	To show his/her ability to the effectively collaboration and inter-professionalism in class discussions or team works, as well as independently.	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)	weekly	30 %
2	Midterm Exam	7 th week	30 %
3	Final Exam	13th week	40 %
4	Total		100%

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice: • **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;** • **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.** • **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.** • **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***Gas chromatography and mass spectrometry:*** A practical guide, Sparkman, O. D.; .Penton, Z.; Kitson, F. G., 2nd Edition, Academic Press, 2011. ISBN: 978-0123736284. ***Chromatography: Principles and Instrumentation*** **,** Vitha, M. F., 1st ed, Wiley, 2016. ISBN: 978-1-119-27088-1 ***Introduction to Modern Liquid Chromatography*** **,** Snyder, L. R.; Kirkland, J. J.; Dolan, J.W., 3rd Edition, Wiley, 2009.ISBN-13: 978-0470167540. ***Comprehensive chromatography in combination with mass spectrometry,*** Mondello, L.,1st Ed, Wiley, 2011.ISBN: 978-0-470-43407-9
Essential Reference Materials	**NONE**
Electronic Materials	• Journal of Chromatography • Separation and purification reviews • Separation and purification technology • Journal of separation science • Saudi Digital Library
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites.

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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.
	Course Responsible	**Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Electroanalytical Chemistry**
Course Code:	**CHM 6235**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: 5 (5 Lectures, 0 Lab, 0 Tutorials)	
2. Course type ☐ Required ☒ Elective	
3. Level/year at which this course is offered: Level 4/Year 2	
4. Pre-requisites for this course (if any): Advanced Analytical Chemistry - CHM 6131	
5. Co-requisites for this course (if any): None	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

The course is designed to cover an introduction to electrochemistry, electrochemical cells, Nernst equation, electrode potentials, formal potential, and limitations of electrode potentials. The topics include advanced aspects of potentiometry, conductometry, coulometry, polarography, amperometry, voltammetry, and stripping methods.

2. Course Main Objective

At the end of the course, the students will be able to:

- Recognize the basic and advanced principles of electrochemical method employed in chemical analysis.
- Be familiar with the fundamentals of current and potential and their mathematical relations.
- Develop awareness of electrochemical techniques for analysis.
- Interpret the electrochemical analysis results.

3. Course Learning Outcomes

	CLOs *After completion of the course, The Graduate is able to*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	**To recall the principles of electroanalytical techniques.**	**K1. *Anal.*; K2. *Anal.*; K4. Anal.**
1.2	**To describe Oxidation/Reduction Reactions Characterization.**	**K2. *Anal.*; K4. *Anal.***
1.3	**To outline essential electrochemical concepts.**	**K2. *Anal.*; K3. *Anal.*; K4. *Anal.***
1.4	**To state Electrochemical Methods of Analysis**.	**K2. *Anal.*; K4. *Anal.***
2	**Skills:**	
2.1	**To explain Voltammetry and Applications of Voltammetry and Stripping Methods.**	**S1. *Anal.*; S2. *Anal.*; S3. *Anal.***
2.2	**To calculate Concentrations from Potential Measurements.**	**S2. *Anal.*; S3. *Anal.***
2.3	**To interpret electrochemical data employing the different methods.**	**S2. *Anal.*; S3. *Anal.***
2.4	**To illustrate different electroanalytical techniques and their applications through oral presentation, and accompanying writing of mini- Reports, operating electronic mail, and Networks in communicating with others..**	**S1. *Anal.*; S3. *Anal.* S4. *Anal.***
3	**Values:**	
3.1	**To show a scientific presentation independently and integrate with a collaborated group to acquire, analyze, and communicate information.**	**V1. *Anal.***
3.2	**To use his/her ability to be an effective and active collaborator with inter-professionalism in teamwork, and make decisions, develop knowledge, and enhance society's quality as well as independently.**	**V1. *Anal.*; V2. *Anal.***

C. Course Content

No	List of Topics	Contact Hours
1	***Introduction:*** Characterizing Oxidation/Reduction Reactions, Balancing Redox Equations, Electrochemical Cells, Electrode Potentials, formal potential, limitations of electrode potentials, and Nernst Equation**.**	**16**
2	***Electrochemical Methods of Analysis*:** Potentiometry, conductometry, coulometry, polarography, amperometry, voltammetry.	**12**
3	***Potentiometry:*** General Principles, Liquid-Junction Potentials, Reference Electrodes, Determination of Concentrations from Potential Measurements.	**20**
4	***Voltammetry:*** Principles, Voltammetric Instrumentation, Cyclic Voltammetry, Applications of Voltammetry and Stripping Methods.	**12**
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	**To recall the principles of electroanalytical techniques.**	▪ Five hours/week lectures. ▪ Self-study ● Homework	▪ Regular Exams. ▪ Assignments ▪ Short Quizzes. ▪ Oral Discussion. ▪ Participation.
1.2	**To describe Oxidation/Reduction Reactions Characterization.**	▪ Five hours/week lectures. ▪ Think to justify The Oxidation/Reduction Reactions, using available references (SDL) online ▪ Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.3	**To outline essential electrochemical concepts.**	▪ Five hours/week lectures. ▪ Open Discussion with mini-reports to justify electrochemical concepts using available references (SDL) online.	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.4	**To state Electrochemical Methods of Analysis.**	▪ Five hours/week lectures. ▪ Group Discussion using available references (SDL).	▪ Assignments ▪ Open Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
2.0	**Skills**		
2.1	**To explain Voltammetry and Applications of Voltammetry and Stripping Methods.**	▪ Lectures activity ▪ Self-study. ▪ Think, and discuss Applications of Voltammetry deeply.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation ▪ Mini -seminar.
2.2	**To calculate Concentrations from Potential Measurements.**	▪ Practice some examples for Calculating Concentrations from Potential Measurements. ▪ Brainstorming. ▪ Self-study.	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion ▪ Short Quizzes.
2.3	**To interpret electrochemical data employing the different methods.**	▪ Lectures ▪ Oral Discussions. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion. ▪ Participation.

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
2.4	**To illustrate different electroanalytical techniques and their applications through oral presentation, and accompanying writing of mini- Reports, operating electronic mail, and Networks in communicating with others.**	▪ Group Discussion and Assignments ▪ Suggest several examples of obtained results from different electroanalytical techniques used used to study which will require 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		
3.1	**To show a scientific presentation research, and integrating with a research group, to acquire, analyze, and exchange information.**	▪ Brainstorming. ▪ Exercises ▪ Group Discussion. ▪ Team work.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	**To use his/her ability to be an effective and active collaborator with inter-professionalism in teamwork, and make decisions, develop knowledge, and enhance society's quality as well as independently.**	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	**Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)**	**weekly**	**30 %**
2	**Midterm Exam**	**7 th week**	**30 %**
3	**Final Exam**	**13th– week**	**40 %**
4	**Total**		**100%**

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice: • **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;** • **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.** • **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.** • **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***Fundamentals of analytical chemistry*** , Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch., 9th Edition. ISBN-13: 978-0-495-55828-6. ***Analytical Chemistry,*** Gary D. Christian, Purnendu K. (Sandy) Dasgupta, Kevin A. Schug. Analytical Chemistry, 7th Edition. ISBN: 978-0-470-88757-8.
Essential Reference Materials	**NONE**
Electronic Materials	• Journal of Analytical Chemistry • Saudi Digital Library
Other Learning Materials	• Blackboard. • Multimedia associated with the text book and the relevant websites.

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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.
	Course Responsible	**Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Selected Topics in Analytical Chemistry**
Course Code:	**CHM 6237**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: **5 (5 Lectures, 0 Lab, 0 Tutorials)**	
2. Course type ☐ Required ☒ Elective	
3. Level/year at which this course is offered: **Level 5/Year 2**	
4. Pre-requisites for this course (if any): **Advanced Analytical Chemistry - CHM 6131**	
5. Co-requisites for this course (if any): **None**	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		**60**

B. Course Objectives and Learning Outcomes

1. Course Description

The course covers selected topics in analytical chemistry suggested by CGC forward to the approved by the head of department and the department council each time this course is offered.

2. Course Main Objective

At the end of the course, the students will be able to:

- **Enable students to enrich their knowledge with different special topics of interest, which are carefully selected from Analytical Chemistry topics.**
- **Learn topics those are not formally offered by the program and receive appropriate academic credit.**
- **Recognize the hot topics in the Analytical Chemistry.**

3. Course Learning Outcomes

	CLOs	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To be specified according to the selected topics	Depending on.
1.2		
1.3		
1.4		
2	**Skills:**	
2.1	To be specified according to the selected topics.	Depending on.
2.2		
2.3		
2.4		
3	**Values:**	
3.1	To be specified according to the selected topics.	Depending on.
3.2		

C. Course Content

No	List of Topics	Contact Hours
1	Specific to Selected topics in Analytical Chemistry	66
2		
3		
4		
5		
6		
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
1.0	**Knowledge and Understanding**		
1.1-1.4	To be specified according to the selected topics		
2.0	**Skills**		
2.1-2-4	To be specified according to the selected topics		
3.0	**Values**		
3.1- 3.2	To be specified according to the selected topics		

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)	weekly	30 %
2	Midterm Exam	7 th week	30 %
3	Final Exam	13th week	40 %
4	Total		100%

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice:

- **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;**
- **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.**
- **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.**
- **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	To be specified according to the selected topics
Essential Reference Materials	To be specified according to the selected topics
Electronic Materials	• To be specified according to the selected topics Saudi Digital Library
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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	

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Spectroscopic Methods**
Course Code:	**CHM 6236**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: 5 (5 Lectures, 0 Lab, 0 Tutorials)	
2. Course type ☐ Required ☒ Elective	
3. Level/year at which this course is offered: Level 5/Year 2	
4. Pre-requisites for this course (if any): Advanced Analytical Chemistry - CHM 6131	
5. Co-requisites for this course (if any): None	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

This course is designed to cover aspects of common spectroscopic techniques used in analytical chemistry. It will cover Introduction to Spectrochemical Methods and optimization of analytical processors. It will give an extensive knowledge of Instrumentation and theoretical aspects of Molecular Absorption Spectrometry, and Molecular Fluorescence Spectroscopy. It will extend to Atomic Spectroscopy.

2. Course Main Objective

At the end of the course, the students will be able to:

- Optimize spectroscopic method for a particular type of a sample.
- Recognize the optimization of analytical processors.
- Develop awareness with all analytical spectrometry instruments and techniques.
- Interpret the analytical spectrometry results.

3. Course Learning Outcomes

	CLOs *After completion of the course, The Graduate is able to*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	**To memorize the principles of a wide range of Modern Analytical Atomic Spectroscopy Methods of Analysis.**	**K1. *Anal.*; K2. *Anal.*; K4. Anal.**
1.2	**To list the Spectrometric Instrumentation, and its application.**	**K2. *Anal.*; K4. *Anal.***
1.3	**To outline a suitable Analytical Spectroscopic Method to analyse specific samples.**	**K2. *Anal.*; K4. *Anal.***
1.4	**To state Applications of Spectroscopic Methods in Analytical Chemistry**.	**K2. *Anal.*; K3. *Anal.***
2	**Skills:**	
2.1	**To analyze data and interpret results for complex samples with different matrix constituents.**	**S1. *Anal.*; S2. *Anal.*; S3. *Anal.***
2.2	**To explain experimental setup for Spectrometric Instrumentation**	**S2. *Anal.*; S3. *Anal.***
2.3	**To justify the selection of proper spectroscopic techniques to analyze various samples**	**S1. *Anal.*; S2. *Anal.*; S3. *Anal.***
2.4	**To interpret different isolated results from different Spectroscopic techniques used, with accompanying writing of mini- Reports, operating electronic mail, and Networks in communicating with others.**	**S1. *Anal.*; S4. *Anal.***
3	**Values:**	
3.1	**To show a scientific presentation and manage a research project independently, with participating in a collaborated group to acquire, analyze, and exchange information.**	**V1. *Anal.***
3.2	**To use his/her ability to effective collaboration and inter-professionalism in class discussions or team works, as well as independently.**	**V1. *Anal.*; V2. *Anal.***

C. Course Content

No	List of Topics	Contact Hours
1	***Introduction to Spectrochemical Methods***: Electromagnetic Radiation, Interaction of Electromagnetic Radiation with Matter, Electronic Spectra and Molecular Structure, Infrared Absorption, and Beer's Law.	**15**
2	***Spectrometric Instrumentation:*** Sources, Monochromators, Sample cells, Detectors, Types of Instruments (Single beam spectrometer, and Double beam spectrometers), and Fourier Transform Infrared Spectrometers	**10**
3	***Molecular Absorption Spectrometry:*** Absorption by Organic Compounds, Absorption by Inorganic Species, Charge-Transfer Absorption, Ultraviolet and Visible Molecular Absorption Spectroscopy, Infrared Absorption Spectroscopy.	**15**
4	***Molecular Fluorescence Spectroscopy:*** Principles, Relationship between concentration and fluorescence intensity, Fluorescence Instrumentation and Molecular Phosphorescence Spectroscopy.	**13**
5	***Atomic Spectroscopy:*** Principles, Atomic Absorption Spectrometry, and Atomic Emission Spectrometry: The Induction Coupled Plasma (ICP).	**7**
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	**To memorize the principles of a wide range of Modern Analytical Atomic Spectroscopy Methods of Analysis.**	▪ Five hours/week lectures. ▪ Self-study ● Homework.	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion ▪ Participation.
1.2	**To list the Spectrometric Instrumentation, and its application.**	▪ Five hours/week lectures. ▪ Think and justify The Spectrometric Instrumentation, using available references (SDL) online. ▪ Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.3	**To outline a suitable Analytical Spectroscopic Method to analyse specific samples.**	▪ Five hours/week lectures ▪ Open Discussion with mini-reports to justify suitable analytical spectroscopic method using available references (SDL) online.	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.4	**To state Applications of Spectroscopic Methods in Analytical Chemistry.**	▪ Five hours/week lectures. ▪ Group Discussion using available references (SDL)	▪ Assignments ▪ Open Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
2.0	**Skills**		
2.1	**To analyze data and interpret results for complex samples with different matrix constituents.**	▪ Lectures activity ▪ Self-study. ▪ Think, and discuss analyzing the obtained results for complex samples	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation ▪ Mini -seminar.
2.2	**To explain experimental setup for Spectrometric Instrumentation.**	▪ Practice some examples for experimental setup of different instruments. ▪ Brainstorming. ▪ Self-study.	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion ▪ Short Quizzes.
2.3	**To justify the selection of proper spectroscopic techniques to analyze various samples.**	▪ Lectures ▪ Oral Discussions. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion. ▪ Participation.

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
2.4	**To interpret different isolated results from different Spectroscopic techniques used, with accompanying writing of mini- Reports, operating electronic mail, and Networks in communicating with others.**	▪ Group Discussion and Assignments ▪ Practice on several examples of isolated results from different spectroscopic techniques used to study, which will require 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**		
3.1	**To show a scientific presentation and manage a research project independently, with participating in a collaborated group to acquire, analyze, and exchange information.**	▪ Brainstorming. ▪ Exercises. ▪ Group Discussion. ▪ Team work.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	**To use his/her ability to effective collaboration and inter-professionalism in class discussions or team works, as well as independently.**	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects.	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	**Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)**	**weekly**	**30 %**
2	**Midterm Exam**	**7th week**	**30 %**
3	**Final Exam**	**13th week**	**40 %**
4	**Total**		**100%**

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F. Learning Resources and Facilities

1. Learning Resources

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Essential Reference Materials	**NONE**
Electronic Materials	• Spectrochimica Acta - Part B: Atomic Spectroscopy • Journal of Analytical Atomic Spectrometry • Spectroscopy Letters • Saudi Digital Library
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites.

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	**Direct:** Questionnaire.
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	Program Leaders	**Indirect:** Exams.
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	

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد NCAAA

T15

Course Specifications (Postgraduate Degree)

Course Title:	**Statistics in Analytical Chemistry**
Course Code:	**CHM 6132**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: 5 (5 Lectures, 0 Lab, 0 Tutorials)	
2. Course type ☐ Required ☒ Elective	
3. Level/year at which this course is offered: Level 3/Year 1	
4. Pre-requisites for this course (if any): Advanced Analytical Chemistry - CHM 6131	
5. Co-requisites for this course (if any): None	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

This course will cover Mean, Median, Precision, Measures of Precision, and Accuracy. The topics include types of Errors in Experimental Data, Gaussian curve, and Reporting Computed Data (Significant Figures and rounding data). It will extend to cover statistical data treatment, least square methods, Correlation Coefficient, and Detection Limits.

2. Course Main Objective

- Outline all aspects of Statistics in analytical chemistry.
- Acquisition of information on Mean, Median, Precision, Measures of Precision, and Accuracy.
- Develop awareness with types of Errors in Experimental Data.
- Be familiar with Reporting Computed Data and statistical data treatment.
- Recognize least square methods, Correlation Coefficient, and Detection Limits

3. Course Learning Outcomes

	CLOs *After completion of the course, The Graduate is able to*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recall the principles of Statistics in Analytical Chemistry.	K1. *Anal.*; K2. *Anal.*; K4. *Anal.*
1.2	To recognize basic principles of Mean, Median, Precision, Measures of Precision, and Accuracy.	K1. *Anal.*; K2. *Anal.*; K4. *Anal.*
1.3	To outline the types of Errors in Experimental Data that arise.	K1. *Anal.*; K2. *Anal.*; K4. *Anal.*
1.4	To state the basic principles of Reporting Computed Data and statistical data treatment.	K1. *Anal.*; K2. *Anal.*; K4. *Anal.*
2	**Skills:**	
2.1	To analyze data and interpret results by statistical methods for complex samples with different matrix constituents.	S1. *Anal.*; S2. *Anal.*; S3. *Anal.*
2.2	To design experimental setup for computing data isolated.	S2. *Anal.*; S3. *Anal.*
2.3	To justify Comparison of two measured values (Paired t-test)	S2. *Anal.*; S3. *Anal.*
2.4	To illustrate application of Statistics in analytical chemistry, through oral presentation, and accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others	S1. *Anal.*; S3. *Anal.* S4. *Anal.*
3	**Values:**	
3.1	To show a scientific presentation independently and integrate with a collaborated group to acquire, analyze, and communicate information.	V1. *Anal.*
3.2	To use his/her capability to act effectively and actively through collaboration and inter-professionalism in class discussions or teamwork, as well as independently.	V1. *Anal.*; V2. *Anal.*

C. Course Content

No	List of Topics	Contact Hours
1	***Mean, Median, Precision, and Accuracy***	**10**
2	***Types of Errors in Experimental Data (Systematic errors and Random errors), and Gaussian curve. A Measure of Precision:*** The standard deviation, the relative standard deviation (RSD), variance, the coefficient of variation (CV), and the spread.	**15**
3	***Reporting Computed Data: Significant figures, Significant figures in numerical computations, and rounding data***	**15**
4	***Statistical Data Treatment and Evaluation:*** Confidence intervals, confidence limits, Comparing an experimental mean with true value, Comparison of two measured values (Paired t-test), Rejection of outlier results (Q-test).	**13**
5	***Least square methods, Correlation Coefficient, and Detection Limits***	**7**
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
1.0	**Knowledge and Understanding**		
1.1	**To recall the principles of Statistics in Analytical Chemistry.**	▪ Five hours/week lectures. ▪ Self-study ▪ Homework	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion ▪ Participation.
1.2	**To recognize basic principles of Mean, Median, Precision, Measures of Precision, and Accuracy.**	▪ Five hours/week lectures. ▪ Think and justify the Mean, Median, Precision, Measures of Precision, and Accuracy principles using available references (SDL) online. ▪ Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation
1.3	**To outline the types of Errors in Experimental Data that arise.**	▪ Five hours/week lectures. ▪ Group Discussion to justify types of Errors in Experimental Data using available references (SDL) online.	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.4	**To state the basic principles of Reporting Computed Data and statistical data treatment.**	▪ Five hours/week lectures. ▪ Group Discussion using available references (SDL) online.	▪ Assignments ▪ Open Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
2.0	**Skills**		
2.1	**To analyze data and interpret results by statistical methods for complex samples with different matrix constituents.**	▪ Lectures activity ▪ Self-study. ▪ Think, and discuss on analyzing and interpretation of statistical data for complex samples	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation ▪ Mini -seminar.
2.2	**To design experimental setup for computing data isolated.**	▪ Practice some examples for experimental setup of computing data isolated. ▪ Brainstorming. ▪ Self-study.	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion ▪ Short Quizzes.
2.3	**To justify Comparison of two measured values (Paired t-test).**	▪ Lectures ▪ Oral Discussions. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams.

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
			▪ Oral Discussion. ▪ Participation.
2.4	To illustrate application of Statistics in analytical chemistry, through oral presentation, and accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others	▪ Group Discussion and Assignments. ▪ Apply several examples of obtained results statistically to analyze, which will require 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		
3.1	To show a scientific presentation independently and integrate with a collaborated group to acquire, analyze, and communicate information.	▪ Brainstorming. ▪ Exercises ▪ Group Discussion. ▪ Team work. ▪	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	To use his/her capability to act effectively and actively through collaboration and inter-professionalism in class discussions or teamwork, as well as independently.	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)	weekly	30 %
2	Midterm Exam	7th week	30 %
3	Final Exam	13th week	40 %
4	Total		100%

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice: • **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;** • **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.** • **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.** • **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***Fundamentals of analytical chemistry,*** Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch. 9th Edition. ISBN-13: 978-0-495-55828-6. ***Analytical Chemistry,*** Gary D. Christian, Purnendu K. (Sandy) Dasgupta, Kevin A. Schug.7th Edition. ISBN: 978-0-470-88757-8.
Essential Reference Materials	**NONE**
Electronic Materials	• Saudi Digital Library
Other Learning Materials	• Blackboard. • Multimedia associated with the text book and the relevant websites

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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.
	Course Responsible	**Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Selected Topics in Inorganic Chemistry**
Course Code:	**CHM 6114**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: 5 (5 Lectures, 0 Lab, 0 Tutorials)	
2. Course type ☐ Required ☒ Elective	
3. Level/year at which this course is offered: Level 3/Year 1	
4. Pre-requisites for this course (if any): Inorganic Molecular Spectroscopy – CHM 6111	
5. Co-requisites for this course (if any): None	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

List of Topics, Specific to recent topics in Inorganic Chemistry

2. Course Main Objective

- This course enables students to enrich their knowledge with different special topics of interest, which are carefully selected from Inorganic Chemistry topics. The course covers selected topics in inorganic chemistry suggested by CGC and approved by the head of department and the department council each time this course is offered.
- To learn topics those are not formally offered by the program and receive appropriate academic credit.

3. Course Learning Outcomes

	CLOs	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To be specified according to the selected topics	Depending on.
1.2		
1.3		
1.4		
2	**Skills:**	
2.1	To be specified according to the selected topics	Depending on.
2.2		
2.3		
2.4		
3	**Values:**	
3.1	To be specified according to the selected topics	Depending on.
3.2		

C. Course Content

No	List of Topics	Contact Hours
1	Specific to recent Selected topics in Inorganic Chemistry	60
2		
3		
4		
5		
6		
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and Understanding		
1.1-1.4	To be specified according to the selected topics		
2.0	Skills		
2.1-2-4	To be specified according to the selected topics		
3.0	Values		
3.1- 3.2	To be specified according to the selected topics		

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)	weekly	30 %
2	Midterm Exam	7 th week	30 %
3	Final Exam	13th week	40 %
4	Total		100%

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice:

- Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	To be specified according to the selected topics
Essential Reference Materials	To be specified according to the selected topics
Electronic Materials	• To be specified according to the selected topics • Saudi Digital Library
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites.

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show, Smart Board, WI-FI access.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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	

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	Council of Chemistry Department
Reference No.	10 (No. 2/10)
Date	21/04/1444- 15/11/2022

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Chemistry and Technology of Inorganic Materials**
Course Code:	**CHM 6216**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: **5 (5 Lectures, 0 Lab, 0 Tutorials)**	
2. Course type ☐ Required ☒ Elective	
3. Level/year at which this course is offered: **Level 4/Year 2**	
4. Pre-requisites for this course (if any): **Inorganic Molecular Spectroscopy – CHM 6111**	
5. Co-requisites for this course (if any): **None**	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

The course includes basics of different ores bearing minerals and the chemical composition of such minerals. The course also, includes the several industries purifications and synthesis of the important metals for strategic industries. The applications of these metal industries, are classified in terms of, the raw materials, and advanced process in the steel and ceramic industries. The course will extend the Aluminum, Lead, cement, glasses, copper industries and the chemical reaction for their manufacturing procedure. Metallurgical Processes and Metals is one of the topics that will cover in this course. It provides information on chemical changes associated with transformation of powder cement into a solid. The course includes the introduction to advanced composite materials and its important applications in different branches of live. The practical part of this course consists of a set of experiments that reinforce the quality control principles for the analysis of raw materials such as limestone, calcium oxide and silica.

2. Course Main Objective

- Recognize various ores and minerals
- Be Fimiliar with different extraction methods for different applications.
- Enrich the knowledge for the most famous strategic industries such as ceramics, steel glass and building materials in KSA.
- Develop awareness advanced inorganic compounds and their applications.

3. Course Learning Outcomes

	CLOs *After completion of the course, The Graduate is able to*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recall knowledge *of* Different Ores bearing minerals and their Industrial Applications.	K1. *Inorg*.; K2. . *Inorg*.; K4. *Inorg*.
1.2	To state The Chemical Compositions of Minerals.	K1. *Inorg*.; K4. *Inorg*.
1.3	To describe the processes for minerals extraction for inorganic applications.	K1. *Inorg*.; K3. *Inorg*.; K4. *Inorg*.
1.4	To recognize the applications of the advanced composite materials.	K3. *Inorg*.; K4. *Inorg*.
2	**Skills:**	
2.1	To explain the processes for minerals extraction for inorganic Applications.	S1. *Inorg*.; S2. *Inorg*.
2.2	To summarize strategic industries of the minerals.	S1. *Inorg*.; S2. *Inorg*.; S4. *Inorg*.
2.3	To show the advanced composite materials applications.	S1. *Inorg*.; S2. *Inorg*.; S3. *Inorg*.
2.4	To evaluate, the importance and applications of Advanced Inorganic Composites in KSA, with accompanying writing of mini-Reports, operating electronic mail, and Networks in communicating with others	S1. *Inorg*.; S3. *Inorg*.; S4. *Inorg*.
3	**Values:**	
3.1	To show a scientific presentation and manage a research project independently, and participating in a collaborated group to acquire, analyze, and exchange information.	V1. *Inorg*.
3.2	To use his/her ability to effective collaboration and inter-professionalism in teamwork, and evaluate to make decisions, develop knowledge, and enhance society's quality as well as independently.	V1. *Inorg*.; V2. *Inorg*.

C. Course Content

No	List of Topics	Contact Hours
1	***The Different Ores bearing minerals and their Industerial Applications*:** Iron Ores for steel production- Copper Ores - lead Oress- Glasses Ores-Aluminum Ores – Chromium Ores.	**10**
2	***The Chemical Compositions of Minerals:*** Chemical Compositions of Iron and Its Compounds-Chemical Composition of Copper- Chemical Composition of Lead- Chemical Composition of Aluminum and its Oxides- Chemical Composition of Different Glasses – Chemical Composition of Chromium and its compounds	**10**
3	***Proceses for Minerals Extraction for Inorganic Applications:*** Blast furnace for Iron and different Alloys production- Melting and Bessmerization for copper production – Electrolysis, Baeyer's process, Serpeck's process for Alumium production – Reduction Processes for Chrom production- Air Reduction and Carbon Reduction process for Lead Production.	**10**
4	***Stratigic Industries of the Minerals:*** Ceramics Industries- Building Materials – Steel Industries- Glas Industries**.**	**10**
5	***Manufacture of the Advanced Inorganic Composites*:** Introduction to the Composite Materials – Examples of the Composites like Carbon nanotubes and Aluminium Oxide.	**10**
6	***Applications of the Advanced Composite Materials:*** Midicen-Water treatment – Environments- Aircraft- Automobiles- Nuclear sector**.**	**10**
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	**To recall knowledge of Different Ores bearing minerals and their Industrial Applications.**	▪ Five hours/week lectures. ▪ Self-study ▪ Homework.	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion ▪ Participation.
1.2	**To state The Chemical Compositions of Minerals.**	▪ Five hours/week lectures. ▪ Think and justify The Chemical Compositions of Minerals, using available references (SDL) online. ▪ Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.3	**To describe the processes for minerals extraction for inorganic applications.**	▪ Five hours/week lectures. ▪ Group Discussion using available references (SDL) online.	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.4	**To recognize the applications of the advanced composite materials.**	▪ Five hours/week lectures. ▪ Group Discussion on Applications of the Advanced Composite Materials using available references (SDL) online.	▪ Assignments ▪ Open Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
2.0	**Skills**		
2.1	**To explain the processes for minerals extraction for inorganic Applications.**	▪ Lectures activity. ▪ Self-study. ▪ Think, differentiate and discuss on metals and ligands inside biological system.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation ▪ Mini -seminar.
2.2	**To summarize strategic industries of the minerals.**	▪ Practice some examples of Minerals Extraction for Inorganic Applications achieving. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion ▪ Short Quizzes.
2.3	**To show the advanced composite materials applications.**	▪ Lectures ▪ Oral Discussions. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion. ▪ Participation
2.4	**To evaluate the importance and applications of Advanced Inorganic Composites in KSA, with accompanying**	▪ Group Discussion and Assignments	▪ Oral Discussion. ▪ Quizzes, and Exams.

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
	writing of mini-Reports, operating electronic mail, and Networks in communicating with others	▪ Introduce several examples of advanced Inorganic Composites and applications of KSA which will require reading, writing, and oral presentation in groups. ▪ Encourage students to use electronic mail to submit Home Exams and Assignments	▪ Giving marks for Oral Discussion in Lectures. ▪ Marks given for Assignments
3.0	**Values**		
3.1	To show a scientific presentation and manage a research project independently, and participating in a collaborated group to acquire, analyze, and exchange information.	▪ Brainstorming. ▪ Exercises ▪ Group Discussion. ▪ Team work.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	To use his/her ability to effective collaboration and inter-professionalism in teamwork, and evaluate to make decisions, develop knowledge, and enhance society's quality as well as independently.	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)	weekly	30 %
2	Midterm Exam	7th week	30 %
3	Final Exam	13th week	40 %
4	Total		100%

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice: • **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;** • **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.** • **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.** • **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***Industrial Inorganic Chemistry***, K. H. Buchel, Moretto, Hans-Heinrich; Werner, D., 2nd Ed., Completely Revised Edition, (2008). ISBN: 978-3-527-61333-5. ***COMPOSITES ANDTHEIR APPLICATIONS***, Ning Hu., First published August, 2012-Printed in Croatia ISBN 978-953-51-0706-4 ***Special Inorganic Cements***, Odler, I. March 23, 2000 by CRC Press,
Essential Reference Materials	**NONE**
Electronic Materials	• American Chemical Society (Relevant Journals) • Saudi Digital Library
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites.

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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.
	Course Responsible	**Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
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T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Advanced Coordination Chemistry**
Course Code:	**CHM 6113**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: 5 (5 Lectures, 0 Lab, 0 Tutorials)	
2. Course type ☐ Required ☒ Elective	
3. Level/year at which this course is offered: Level 3/Year 1	
4. Pre-requisites for this course (if any)**:** Inorganic Molecular Spectroscopy – CHM 6111	
5. Co-requisites for this course (if any)**:** None	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

This course provides students with an introduction of advanced coordination chemistry, Molecular Orbital Treatment, Octahedral (with and without pi bonding) Tetrahedral and Square Planer Complexes in a Qualitative Manner .The course will cover the Synthesis of Coordination Compounds, Reaction of a Metal Salt with a Ligand, Ligand Replacement Reactions, Reaction of Two Metal Compounds, Oxidation-Reduction Reactions as well the Mixed Ligand Complexes. Magnetic Behavior will be included.

2. Course Main Objective

- Recognize the Theories of Metal-Ligand bonding.
- Be familiar for Transition Metal Preparation.
- Elucidate the Coordination Compounds Structures.
- Understand the Mixed Ligand Complexes stability and its role in a biological system.
- Study and compare the Magnetic Behavior of Coordination Compounds.

3. Course Learning Outcomes

	CLOs *After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To list the different theories of Bonding in Complexes.	K1. *Inorg.*; K2. *Inorg.*; K4. *Inorg.*
1.2	To describe the transition metal preparation and study of coordination compounds structures and the magnetic behavior of complexes	K1. *Inorg.*; K4.*Inorg*
1.3	To state the importance of coordination chemistry in the biological systems.	K3. *Inorg.*; K4.*Inorg*
1.4	To define the application Mimicking reactions in biological systems, Magnetic Behavior and Magnitude of Magnetic Moments.	K1. *Inorg.*; K3.*Inorg.*; K4.*Inorg.*
2	**Skills:**	
2.1	To explain the concepts of different theories in the coordination and complexes chemistry.	S1. *Inorg.*; S2. *Inorg.*
2.2	To summarize the different methods for Transition Metals preparation and studies of Coordination compounds structures.	S1. *Inorg.*; S2. *Inorg.*
2.3	To justify the magnetic properties relationship with the electronic configurations of complexes.	S1. *Inorg.*; S2. *Inorg.*; S3. *Inorg.*
2.4	To differentiate Coordination Compounds formation and its applications, with accompanying writing of mini-Reports, operating electronic mail, and Networks in communicating with others.	S1. *Inorg.*; S2. *Inorg.*; S4. *Inorg.*
3	**Values:**	
3.1	To demonstrate scientific research, independently and collaborate with groups in relevant topics	V1. *Inorg.*
3.2	To use his/her ability to effective collaboration and inter-professionalism in teamwork, and make decisions, develop knowledge, and enhance society's quality as well as independently.	V1. *Inorg.*; V2.*Inorg.*

C. Course Content

No	List of Topics	Contact Hours
1	***Theories of Metal-Ligand bonding*: ** Molecular Orbital Treatment, Octahedral (with and without pi bonding) Tetrahedral and Square Planer Complexes in a Qualitative Manner, Comparison of Theories of Bonding, Valance Bond Theory (VBT), Crystal-Field Theory (CFT), Ligand Field Theory (LFT) and Molecular Orbital Theory (MOT).	15
2	***Transition Metal Preparation and Structural Studies of Coordination Compounds*:** Synthesis of Coordination Compounds, Reaction of a Metal Salt with a Ligand, Ligand Replacement Reactions, Reaction of Two Metal Compounds, Oxidation-Reduction Reactions, Partial Decomposition, Size and Solubility Relationships, Reactions of Metal Salts with Amine Salts, Compounds of First Transition Series Elements, with Respect to their Electronic spectra, magnetic & thermal properties (DTA, TGA).	15
3	***Mixed Ligand Complexes:*** Stabilities of ternary Complexes, Dynamics of Formation of Ternary complexes reaction of Coordination ligand in Ternary Complexes, Mimicking reactions in biological systems, enzyme models, Amino acids Ester Hydrolysis, Peptide Synthesis & Hydrolysis, Detarbodylation of β-Keto acids.	15
4	***Magnetic Behavior****:* Diamagnetism, Para Magnetism, Ferro & Ferri, Antiferro and Magnetic Interaction, The Origin of Para Magnetism, Magnetic Behavior of Complexes, Simplification of Van Velck Equation, Magnitude of Magnetic Moments, Determination of Magnetic Susceptibility by Gouy and Faraday Method**.**	15
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
1.0	**Knowledge and Understanding**		
1.1	**To list the different theories of Bonding in Complexes.**	▪ Five hours/week lectures. ▪ Self-study ▪ Homework.	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion ▪ Participation.
1.2	**To describe the transition metal preparation and study of coordination compounds structures and the magnetic behavior of complexes**	▪ Five hours/week lectures. ▪ Think and justify the transition metal preparation and coordination compounds structures, using available references (SDL) online. ▪ Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.3	**To state the importance of coordination chemistry in the biological systems.**	▪ Five hours/week lectures. ▪ Group Discussion on coordination chemistry in the biological systems using available references (SDL) online.	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.4	**To define the application Mimicking reactions in biological systems, Magnetic Behavior and Magnitude of Magnetic Moments.**	▪ Five hours/week lectures. ▪ Group Discussion using available references (SDL).	▪ Assignments. ▪ Open Discussions. ▪ Literatures Survey. ▪ Mini-seminar. ▪ Participation.
2.0	**Skills**		
2.1	**To explain the concepts of different theories in the coordination and complexes chemistry.**	▪ Lectures activity ▪ Self-study. ▪ Think, differentiate and discuss the coordination and complexes chemistry theories	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation ▪ Mini -seminar.
2.2	**To summarize the different methods for Transition Metals preparation and studies of Coordination compounds structures.**	▪ Practice some examples for Transition Metals preparation methods achieving. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Participation. ▪ Oral Discussion ▪ Short Quizzes and Exams.
2.3	**To justify the magnetic properties relationship with the electronic configurations of complexes.**	▪ Lectures. ▪ Oral Discussions. ▪ Brain storming Exercises. ▪ Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion. ▪ Participation.
2.4	**To differentiate Coordination Compounds formation and its**	▪ Group Discussion and Assignments.	▪ Oral Discussion, Quizzes, and Exams.

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
	applications, with accompanying writing of mini-Reports, operating electronic mail, and Networks in communicating with others.	▪ Practice on examples for coordination compounds applications, which will require reading, writing, and oral presentation in groups. ▪ Encourage students to use electronic mail to submit Home Exams and Assignments.	▪ Giving marks for Oral Discussion in Lectures. ▪ Marks given for Assignments.
3.0	**Values**		
3.1	**To demonstrate scientific research, independently and collaborate with groups in relevant topics.**	▪ Brainstorming. ▪ Exercises ▪ Group Discussion. ▪ Team work.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	**To use his/her ability to be an effective and active collaborator with inter-professionalism in teamwork, and make decisions, develop knowledge, and enhance society's quality as well as independently.**	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	**Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)**	**weekly**	**30 %**
2	**Midterm Exam**	**7th week**	**30 %**
3	**Final Exam**	**13th week**	**40 %**
4	**Total**		**100%**

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice: • **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;** • **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.** • **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.** • **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***Introduction to Coordination Chemistry***, G. A. Lawrance, John Wiley & Sons Ltd, 2010. ISBN: 978-0-470-51930-1 (HB), 978-0-470-51931-8 (PB). ***Descriptive inorganic, coordination, and solid-state chemistry***, G. E. Rodgers, 3rd Ed., Cengage Learning, 2011, ISBN: 978-0840068460
Essential Reference Materials	**NONE**
Electronic Materials	• European Journal Of inorganic Chemistry • American Chemical Society (Relevant Journals) • Saudi Digital Library**.**
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites.

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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.
	Course Responsible	**Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Advanced Inorganic Chemistry Applications**
Course Code:	**CHM 6217**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: 5 (5 Lectures, 0 Lab, 0 Tutorials)	
2. Course type ☐ Required ☒ Elective	
3. Level/year at which this course is offered: Level 5/Year 2	
4. Pre-requisites for this course (if any): Inorganic Molecular Spectroscopy – CHM 6111	
5. Co-requisites for this course (if any): None	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

The course aims to provide students with advanced knowledge related to the utilization of various inorganic materials in some advanced industrial fields, which helps to localize these industries in the future.

2. Course Main Objective

- Recognize the metals and non-metals in industry
- Understand utilization of various inorganic materials in some advanced industrial fields.
- Be familiar with inorganic applications in industries and life

3. Course Learning Outcomes

	CLOs *After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recall knowledge of selected metals and non-metals chemistry in industry.	K1. *Inorg*.; K2. *Inorg*.; K4. *Inorg*.;
1.2	To recognize the basic application of inorganic materials.	K1. *Inorg*.; K2. *Inorg*.; K4. *Inorg*.;
1.3	To state the new applications of inorganic materials.	K1. *Inorg*.; K2. *Inorg*.; K3. *Inorg*.;
2	**Skills:**	
2.1	To analyze methods for studying metals and ligands applications.	S1. *Inorg*.; S2. *Inorg*.; S3. *Inorg*.
2.2	To compare the metals and ligands role in the biological system functions.	S1. *Inorg*.; S4. *Inorg*.;
2.3	To justify advanced inorganic chemistry applications and their importance, with the writing of mini- Reports, operating electronic mail, and Networks in communicating with others.	S1. *Inorg*.; S3. *Inorg*.; S4. *Inorg*.
3	**Values:**	
3.1	To show a scientific presentation, and work independently or with other groups on relevant topics, to analyze, and exchange information.	V1. . *Inorg*.
3.2	To use his/her ability to act effectively and effectively in teamwork, and evaluate to make decisions, develop knowledge, and enhance society's quality as well as independently.	V1. *Inorg*.; V2. *Inorg*.

C. Course Content

No	List of Topics	Contact Hours
1	***Introduction,*** Employment of inorganic materials and compounds in the fields of non-ferrous alloys.	5
2	***Employment and uses of inorganic materials and compounds in advanced biomaterials branches, for example:*** Ceramic and metal bone substitutes, As anti-bacterial such as titanium, wollastonite and copper, As anti-fungal and antivirals.	17
3	***Employment and uses of inorganic materials and compounds*** in jet engines as well as parts of modern cars.	15
4	***Employment and uses of inorganic materials and compounds*** in electrical insulators, as well as in the preparation and manufacture of parts for mobile phones as well as personal computers.	13
5	***Employment and uses of inorganic materials and compounds*** in the fields of water purification and fertilization.	10
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
1.0	**Knowledge and Understanding**		
1.1	**To recall knowledge of selected metals and non-metals chemistry in industry.**	▪ Five hours/week lectures. ▪ Self-study ▪ Homework.	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion ▪ Participation.
1.2	**To recognize the basic application of inorganic materials.**	▪ Five hours/week lectures ▪ Think and justify application of inorganic materials., using available references (SDL) online. ▪ Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation
1.3	**To state the new applications of inorganic materials.**	▪ Five hours/week lectures. ▪ Group Discussion on application of inorganic materials., using available references (SDL) online.	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey. ▪ Mini-seminar. ▪ Participation.
2.0	**Skills**		
2.1	**To analyze methods for studying metals and ligands applications.**	▪ Lectures activity. ▪ Self-study ▪ Deep discussion application of inorganic materials. Lectures activity.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation ▪ Mini -seminar.
2.2	**To compare the metals and ligands role in the biological system functions.**	▪ Practice some examples for application of inorganic materials. In KSA achieving. ▪ Brainstorming. ▪ Self-study.	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion ▪ Short Quizzes.
2.3	**To justify advanced inorganic chemistry applications and their importance, with the writing of mini- Reports, operating electronic mail, and Networks in communicating with others.**	▪ Lectures ▪ Oral Discussions. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion. ▪ Participation
3.0	**Values**		
3.1	**To show a scientific presentation, and work independently or with other groups on relevant topics, to analyze, and exchange information.**	▪ Brainstorming. ▪ Exercises ▪ Group Discussion. ▪ Team work.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	**To use his/her ability to act effectively and effectively in teamwork, and**	▪ Small Group tasks	▪ Participation ▪ Homework's

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
	evaluate to make decisions, develop knowledge, and enhance society's quality as well as independently.	▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects	▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	**Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)**	**weekly**	**30 %**
2	**Midterm Exam**	**7th week**	**30 %**
3	**Final Exam**	**13th week**	**40 %**
4	**Total**		**100%**

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice: • **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;** • **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.** • **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.** • **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***Advanced Components for Electric and Hybrid Electric Vehicles Workshop roceedings*** October 27-28, 1993 Gaithersburg, Maryland K. L. Stricklett, Editor, United States Department of CommerceTechnology Administration National Institute of Standards and Technology NIST Special Publication 860. ***BIOMATERIALS SCIENCE AND ENGINEERING***, Edited by Rosario Pignatello. Published by InTech Janeza Trdine 9, 51000 Rijeka, Croatia, First published August, 2011, Printed in Croatia, ISBN 978-953-307-609-6.
Essential Reference Materials	**NONE**
Electronic Materials	• American Chemical Society (Relevant Journals) • Saudi Digital Library
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites.

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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	

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد NCAAA

T15

Course Specifications (Postgraduate Degree)

Course Title:	**Advanced Inorganic Reaction Mechanisms**
Course Code:	**CHM 6112**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: **5 (5 Lectures, 0 Lab, 0 Tutorials)**	
2. Course type ☐ Required ☒ Elective	
3. Level/year at which this course is offered: **Level 3/Year 1**	
4. Pre-requisites for this course (if any)**:** **Inorganic Molecular Spectroscopy – CHM 6111**	
5. Co-requisites for this course (if any)**:** **None**	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		**60**

B. Course Objectives and Learning Outcomes

1. Course Description

This course provides students for understanding the concepts of the inorganic reaction mechanisms, the Substitution Reactions, Stereochemistry of Octahedral Substitutions, Oxidation-Reduction Reaction. The course will extend to cover Oxidative Additions and Reductive Eliminations, Electron-Transfer Reactions, and Reactions of Free Radicals.

2. Course Main Objective

At the end of the course, the students will be able to:

- **Understand the basic reaction mechanisms of inorganic compounds,**
- **Know mechanistic methods of industrially and ecologically important processes.**
- **Be familiar with the principles and application of fundamental techniques for determination of composition, structure of chemical inorganic compounds.**
- **Have a basic information on the kinds of substitution, redox reaction.**
- **Recognize information on the knowledge accumulated in the field of inorganic reaction mechanisms in relevant areas.**

3. Course Learning Outcomes

	CLOs *After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recognize the substitution reactions for Square-Planer, Tetrahedral and Octahedral complexes.	K1. *Inorg.*; K2. *Inorg.*; K4. *Inorg.*
1.2	To define the mechanisms of the Oxidation- Reduction Reaction, free radicals, and Electron-Transfer Reactions.	K1. *Inorg.*; K4. *Inorg.*
1.3	To describe the Oxidative Additions and Reductive Eliminations reaction mechanisms.	K1. *Inorg.*; K4. *Inorg.*
1.4	To list the application of fundamental techniques for determination of composition, structure of chemical inorganic compounds.	K1. *Inorg.*; K3. *Inorg.*; K4. *Inorg.*
2	**Skills:**	
2.1	To interpret the different types of inorganic reaction mechanisms.	S1. *Inorg.*; S2. *Inorg.*
2.2	To explain the concept of (SN1 and SN2) for the Inorganic Substitution Mechanisms and Electron-Transfer Reactions	S1. *Inorg.*; S2. *Inorg.*
2.3	To justify the appropriate mechanism for the different classes of complexes	S1. *Inorg.*; S2. *Inorg.*; S3. *Inorg.*
2.4	To interpret different types of inorganic reaction mechanisms, and their impact on Industry in KSA, and accompanying writing of mini- Reports, performing electronic mail, and Networks in communicating with others.	S1. *Inorg.*; S2. *Inorg.*; S4. *Inorg.*
3	**Values:**	
3.1	To show a scientific presentation, research, and collaborate with other groups, Using IT to acquire, and analyze information.	V1. *Inorg.*
3.2	To use his/her ability to effective scientific and social collaboration and inter-professionalism in teamwork, as well as independently.	V1. *Inorg.*; V2. *Inorg.*

C. Course Content

No	List of Topics	Contact Hours
1	***Substitution Reactions:*** Molecularity, Factors affecting on the substitution rate, Octahedral complexes, Acid hydrolysis, Anation reaction, Base hydrolysis, Reactions without metal-ligands cleavage, Substitution reactions in non-aqueous solvents.	**10**
2	***Stereochemistry of Octahedral Substitutions*****:** Outer-sphere orientation, Substitution through dissociation (SN1 and SN1) processes, Attacks of reactants on ligands (not on metal), Linkage isomerism, Nucleophilicity in inorganic chemistry, npt Scale, The scale of Swain and Scott, Edwards'scale, The theory of "hard" and "soft" acids and bases, Substitutions on square-planar complexes, The mechanism of ligand replacements, Trans effect, Cis effect, Leaving group effects, Effect of the central metal ion, Substitution reactions of tetrahedral complexes, Substitutions of carbonyls**.**	**10**
3	***Substitution Reactions of Square-Planer Complexes*****:** Factors controlling the reactivity, X-ray studies, trans, cis-effect theories, Polarization and π-bond theories, Effect of solvent, chelation , metal center.	**10**
4	***Oxidation- Reduction Reaction:*** outer-sphere mechanism, Franck-Condon Restrictions, Inner-Sphere mechanism, Two electron transfers.	**10**
5	***Oxidative Additions and Reductive Eliminations:*** Oxidative Additions, Two-electron oxidative additions, Mechanism of Oxidative Addition of the Nucleophilic Substitution Type, One-electron Oxidative Additions, Reductive Eliminations.	**5**
6	***Electron-Transfer Reactions:*** Franck-Condon Principle, Outer-Sphere Electron Transfer, Marcus Theory of Outer-Sphere Electron Transfer, Long-Range Electron Transfers in Biological Systems, Inner-Sphere Electron transfer, Reactions with solvated electrons.	**7**
7	***Reactions of Free Radicals:*** Chain reactions, Stability of the metal-carbon, Oxidation of Transition Metal Complexes by hydroxyl radicals, Reduction of transition metal complexes by organic radicals.	**8**
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
1.0	Knowledge and Understanding		
1.1	**To recognize the substitution reactions for Square-Planer, Tetrahedral and Octahedral complexes.**	▪ Five hours/week lectures. ▪ Self-study. ▪ Homework.	▪ Regular Exams. ▪ Assignments. ▪ Short Quizzes. ▪ Oral Discussion. ▪ Participation.
1.2	**To define the mechanisms of the Oxidation- Reduction Reaction, free radicals, and Electron-Transfer Reactions.**	▪ Five hours/week lectures. ▪ Think, and justify the Oxidation-Reduction, free radicals, and Electron-Transfer Reactions mechanism, using available references (SDL) online. ▪ Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.3	**To describe the Oxidative Additions and Reductive Eliminations reaction mechanisms.**	▪ Five hours/week lectures. ▪ Group Discussion using available references (SDL)	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.4	**To list the application of fundamental techniques for determination of composition, structure of chemical inorganic compounds.**	▪ Five hours/week lectures. ▪ Group Discussion on fundamental techniques of composition determination using available references (SDL) ▪ Open Discussion.	▪ Assignments ▪ Open Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
2.0	Skills		
2.1	**To interpret the different types of inorganic reaction mechanisms.**	▪ Lectures activity. ▪ Self-study ▪ Deep discussion on types of inorganic reaction mechanisms.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation ▪ Mini -seminar
2.2	**To explain the concept of (SN1 and SN2) for the Inorganic Substitution Mechanisms and Electron-Transfer Reactions**	▪ Practice some reaction examples by proposing the reaction mechanism achieving. ▪ Brainstorming.	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion ▪ Short Quizzes.

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
		▪ Self-study.	
2.3	To justify the appropriate mechanism for the different classes of complexes	▪ Lectures and Oral Discussions. ▪ Brain storming Exercises.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion. ▪ Participation
2.4	To interpret different types of inorganic reaction mechanisms, and their impact on Industry in KSA, and accompanying writing of mini- Reports, performing electronic mail, and Networks in communicating with others.	▪ Group Discussion and Assignments ▪ Introduce several examples of inorganic reaction mechanism, which will require 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		
3.1	To show a scientific presentation, research, and collaborate with other groups, Using IT to acquire, and analyze information.	▪ Brainstorming. ▪ Exercises ▪ Group Discussion. ▪ Team work.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	To use his/her ability to effective scientific and social collaboration and inter-professionalism in teamwork, as well as independently.	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)	weekly	30 %
2	Midterm Exam	7th week	30 %
3	Final Exam	13 th week	40 %
4	Total		100%

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice:

- **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;**
- **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.**
- **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.**
- **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***Chemical Kinetics and Inorganic Reaction Mechanisms***, S. Asperger, 2nd Ed., Springer Science, Business Media New York, (2003). ISBN 978-1-4613-4871-9 ISBN 978-1-4419-9276-5 (eBook), DOI 10.1007/978-1-4419-9276-5. ***Reaction Mechanisms of Inorganic and Organometallic Systems***, R. B. Jordan, Oxford University Press 2007. ISBN-10 : 0195301005 , ISBN-13 : 9780195301007.
Essential Reference Materials	**NONE**
Electronic Materials	• European Journal Of inorganic Chemistry • American Chemical Society (Relevant Journals) • Saudi Digital Library.
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites.

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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.
	Course Responsible	**Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد NCAAA

T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Bio-inorganic Chemistry**
Course Code:	**CHM 6215**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: **5 (5 Lectures, 0 Lab, 0 Tutorials)**	
2. Course type ☐ Required ☒ Elective	
3. Level/year at which this course is offered: **Level 4/Year 2**	
4. Pre-requisites for this course (if any)**:** **Inorganic Molecular Spectroscopy – CHM 6111**	
5. Co-requisites for this course (if any)**:** **None**	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

This course provides students with an introduction to Molecular Structure and Function of bio-inorganic compounds, metals and non-metals in biology, and biological ligands for metal ions. The course will extend to cover sodium and potassium, magnesium phosphate metabolism and photoreceptors, copper chemistry, manganese chemistry, iron and oxygen, molybdenum, tungsten, vanadium, and chromium, molybdenum Enzyme families in the biological systems

2. Course Main Objective

- Recognize the metals and non-metals in biology.
- Understand the Basic Coordination Chemistry in the biological system.
- Be familiar with metals inside the biological systems.
- Study and compare the role of metals in the cell and enzymes.
- Evaluate the role of metals and non-metals in the biological system.

3. Course Learning Outcomes

CLOs	*After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recall knowledge of selected metals and non-metals chemistry in biology.	K1. *Inorg*.; K2. *Inorg*.; K4. *Inorg*.;
1.2	To recognize the basic coordination chemistry and biological ligands in the biological system.	K1. *Inorg*.; K2. *Inorg*.; K4. *Inorg*.;
1.3	To define the reactivity of sodium and potassium, magnesium phosphate metabolism and photoreceptors in biological system	K1. *Inorg*.; K2. *Inorg*.; K3. *Inorg*.;
1.4	To state the role Ca2+ and Mg2+, nickel enzymes, methyl-coenzyme, and photosynthetic oxidation.	K1. *Inorg*.; K2. *Inorg*.; K3. *Inorg*.;
2	**Skills:**	
2.1	To analyze methods for studying metals and ligands inside biological system.	S1. *Inorg*.; S2. *Inorg*.; S3. *Inorg*.
2.2	To evaluate the ligands and metals routes inside the biological system.	S1. *Inorg*.; S2. *Inorg*.; S3. *Inorg*.
2.3	To compare the metals and ligands role in the biological system functions.	S1. *Inorg*.; S4. *Inorg*.;
2.4	To illustrate the Basic Coordination Chemistry in the biological system and its importance, and writing of mini-Reports, operating electronic mail, and Networks in communicating with others.	S1. *Inorg*.; S3. *Inorg*.; S4. *Inorg*.
3	**Values:**	
3.1	To demonstrate scientific research, independently and collaborate with groups in relevant topics	V1. . *Inorg*.
3.2	To use his/her ability to effective scientific and social collaboration and inter-professionalism in teamwork, as well as independently.	V1. *Inorg*.; V2. *Inorg*.

C. Course Content

No	List of Topics	Contact Hours
1	***An Overview of Metals and Selected Nonmetals in Biology***: Essential Elements and the Essential Metal Ions, An Idiosyncratic View of the Periodic Table.	5
2	***Basic Coordination Chemistry for Biologists:*** Types of Chemical Bonds, Hard and Soft Ligands, Coordination Geometry, Redox Chemistry.	5
3	***Biological Ligands for Metal Ions***: Insertion of Metal Ions into Metallo-proteins, Chelatase, The Terminal Step in Tetra pyrrole Metallation Iron-Sulfur cluster Formation, More Complex Cofactors- MoCo, FeMoCo, P-clusters, H-clusters, and CuZ, siderophores.	10
4	***Methods to Study Metals in Biological Systems***: Introduction, Magnetic Properties, Electron Paramagnetic Resonance (EPR) Spectroscopy, Mössbauer Spectroscopy, NMR Spectroscopy, Electronic and Vibrational Spectroscopies, Circular Dichroism and Magnetic Circular Dichroism, Resonance Raman Spectroscopy, Extended X-Ray Absorption Fine Structure (EXAFS), X-Ray Diffraction.	5
5	***Sodium and Potassium***: Transport across Membranes, Sodium versus Potassium, Potassium Channels, Sodium Channels, The Sodium-Potassium Atpase, Sodium/Proton Exchangers. Magnesiume Phosphate Metabolism and Photoreceptors: Magnesium-Dependent Enzymes,	7
6	***Phosphoryl Group Transfer Kinases***, Phosphoryl Group Transfer– Phosphatases, Stabilisation of Enolate anions -, Magnesium and Photoreception	5
7	***Calcium***: Comparison of Ca2+ and Mg2+ , The discovery of a Role for Ca2+ Other than as a Structural Component, Regulation and Signalling, Ca2+	3
8	***Nickel and Cobalt***: Nickel Enzymes, Methyl-Co-enzyme M Reductase, Cobalt amine and Cobalt Proteins, B12-Dependent Isomerases, B12-Dependent Methyltransferases.	4
9	***Copper Chemistry***: Copper-Containing Enzymes in Oxygen Activation and Reduction, The Role of Cupper in iron Metabolism.	3
10	***Manganese Chemistry:*** Photosynthetic Oxidation of Water-Oxygen Evolution, Mn2+ and Detoxification of Oxygen Free Radicals, Nonredox di-Mn Enzymes – Arginase,	4
11	***Zinc:*** Mononuclear Zinc Enzymes, Multinuclear and Co-catalytic Zinc Enzymes, Zinc Fingers DNA- and RNA-Binding Motifs	3
12	***Iron and Oxygen:*** The Biological Importance of Iron, Biological Functions of Iron-Containing Proteins, Haemo-proteins.	3
13	***Molybdenum, Tungsten, Vanadium, and Chromium***: Mo and W Chemistry, Molybdenum Enzyme Families, The Xanthine Oxidase Family, The Sulfite Oxidases and DMSO Reductases	3
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
1.0	**Knowledge and Understanding**		
1.1	To recall knowledge of selected metals and non-metals chemistry in biology.	▪ Five hours/week lectures. ▪ Self-study ▪ Homework.	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion ▪ Participation.
1.2	To recognize the basic coordination chemistry and biological ligands in the biological system.	▪ Five hours/week lectures ▪ Think and justify coordination chemistry and biological ligands, using available references (SDL) online. ▪ Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation
1.3	To define the reactivity of sodium and potassium, magnesium phosphate metabolism and photoreceptors in biological system	▪ Five hours/week lectures. ▪ Group Discussion on of reactivity of some elements metabolism and photoreceptors in biological system, using available references (SDL) online.	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey. ▪ Mini-seminar. ▪ Participation.
1.4	To state the role Ca^{2+} and Mg^{2+}, nickel enzymes, methyl-coenzyme, and photosynthetic oxidation.	▪ Five hours/week lectures. ▪ Group Discussion using available references (SDL	▪ Assignments ▪ Open Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
2.0	**Skills**		
2.1	To analyze methods for studying metals and ligands inside biological system.	▪ Lectures activity. ▪ Self-study ▪ Deep discussion on metals and ligands inside biological system. ▪ Lectures activity.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation ▪ Mini -seminar.
2.2	To evaluate the ligands and metals routes inside the biological system.	▪ Practice some examples for some ligands and metals routes interpretation inside the biological system achieving. ▪ Brainstorming. ▪ Self-study.	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion ▪ Short Quizzes.
2.3	To compare the metals and ligands role in the biological system functions.	▪ Lectures ▪ Oral Discussions. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams.

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
			▪ Oral Discussion. ▪ Participation
2.4	To illustrate the Basic Coordination Chemistry in the biological system and its importance, and writing of mini-Reports, operating electronic mail, and Networks in communicating with others.	▪ Group Discussion and Assignments ▪ Introduce several examples of Basic Coordination Chemistry in the biological system, which will require 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		
3.1	To demonstrate scientific research, independently and collaborate with groups in relevant topics	▪ Brainstorming. ▪ Exercises ▪ Group Discussion. ▪ Team work.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	To use his/her ability to effective scientific and social collaboration and inter-professionalism in teamwork, as well as independently.	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)	weekly	30 %
2	Midterm Exam	7th week	30 %
3	Final Exam	13th week	40 %
4	Total		100%

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice: • Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support; • The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties. • Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website. • A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***Biological Inorganic Chemistry, A New Introduction to Molecular Structure and Function***, R. Crichton, 2^{nd} Ed., The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, UK, (2012). ISBN: 9780444537829 ***Bioinorganic Chemistry***, I. Bertini,; H. B. Gray, S. Lippard, J. S. Valentine, University Science Books, Mill Valley, California (1994), ISBN 0-935702-57-1.
Essential Reference Materials	**NONE**
Electronic Materials	• American Chemical Society (Relevant Journals) • Saudi Digital Library
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites.

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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.
	Course Responsible	**Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Advanced Bio-Organic Chemistry**
Course Code:	**CHM 6225**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: **5 (5 Lectures, 0 Lab, 0 Tutorials)**	
2. Course type ☐ Required ☒ Elective	
3. Level/year at which this course is offered: **Level 4/Year 2**	
4. Pre-requisites for this course (if any): **Advanced Organic Chemistry – CHM 6121**	
5. Co-requisites for this course (if any): **None**	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

This course covers topics related to the essential role of enzymes such as biological importance, reaction mechanisms, and their application in drug design and development.

2. Course Main Objective

At the end of the course, the students will be able to:

- **Recognize the general principles and strategies involved in discovering and designing new drugs and how to develop them.**
- **Understand the structure and function of important drug targets and how drugs interact with their molecular targets and the consequences of those interactions.**
- **Explain the structure and biological activity of different Enzymes.**
- **Describe the basic properties of enzymes and their mechanisms of action.**
- **Understand the structure and biological function of Coenzymes.**

3. Course Learning Outcomes

CLOs *After completion of the course, The Graduate is able*		Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recall Drug discovery and Dug Design development	K1. *Org*.; K2. *Org*.; K3. *Org*.
1.2	To outline the Chemical Reaction Mechanism during enzymatic process as a catalyst	K1. *Org*.; K2. *Org*.; K3. *Org*.
1.3	To describe the role of enzymes in Organic Synthesis as Bio-catalysis.	K2. *Org*.; K4. *Org*.
1.4	To state the Reaction Catalyzed by enzymes types	K3. *Org*.; K4. *Org*.
2	**Skills:**	
2.1	To explain the role of enzymes as a Catalyst in Chemical Reaction.	S1. *Org*.; S2. *Org*.
2.2	To justify Prodrug and Drug Delivery Systems in actions.	S1. *Org*.; S4. *Org*.
2.3	To outline the advantage of Bio-catalysis in Organic Synthesis.	S1. *Org*.; S3. *Org*. S4. *Org*.
2.4	To predict the role of Enzymes in Organic Synthesis, Reaction Mechanisms and its applications, and writing of mini-Reports, operating electronic mail, and Network in communicating with others.	S1. *Org*.; S4. *Org*.
3	**Values:**	
3.1	To demonstrate scientific research, independently and collaborate with groups in relevant topics.	V1. *Org*.
3.2	To use his/her capability to be an effective and active collaborator with inter-professionalism in research team , to develop knowledge, and enhance society's quality as well as independently.	V1. *Org*.; V2. *Org*.

C. Course Content

No	List of Topics	Contact Hours
1	***Drug discovery:-***Drug discovery without a lead; penicillins, Librium, Lead discovery; Random Screening, Focused Screening, Drug metabolism studies. Drug receptor interactions.	**5**
2	***Dug design and development:*** Strategies in drug design, Identification of the pharmacophore, Functional group modification, structural-activity relationships, Structure modification to increase potency and the therapeutic index, Structure modification to increase oral Bioavailability.	**10**
3	***Prodrug and drug delivery systems:-***Utility of prodrug; Absorption and Distribution, Site specificity, Toxicity, Types of prodrugs, Mechanism of Drug Activation; Carrier-Linkage for various functional groups; Alcohols, Carboxylic acids, Amines, sulfonamides, Carbonyl compounds.	**10**
4	***Enzymes as catalysts:-***What are enzymes? How do enzymes work?, Specificity of Enzyme-catalyzed Reactions; Binding specificity, Reaction specificity, Rate acceleration	**15**
5	***Mechanisms of Enzyme catalysis***:-Approximation, Covalent Catalysis, Acid-Base catalysis, Desolvation, Strain and distortion, Example of some typical enzyme mechanisms.	**10**
6	***Kind of reaction catalyzed by enzymes:-***Nucleophilic displacement on a phosphorus atom, multiple displacement reactions and the coupling af ATP cleavage to endergonic processes. Transfer of sulphate addition and elimination reactions, enolic intermediates in isomerization reactions, β –cleavage and condensation, some isomerization and rearrangement reactions. Enzyme catalyzed carboxylation and decarboxylation reactions.	**10**
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
1.0	**Knowledge and Understanding**		
1.1	**To recall Drug Discovery and Dug Design development.**	▪ Five hours/week lectures. ▪ Self-study. ▪ Homework	▪ Regular Exams. ▪ Assignments. ▪ Short Quizzes. ▪ Oral Discussion. ▪ Participation.
1.2	**To outline the Chemical Reaction Mechanism during Enzymatic process as a Catalyst.**	▪ Five hours/week lectures. ▪ Think, and justify the chemical enzymatic reaction mechanism, using available references (SDL) online. ▪ Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.3	**To describe the role of Enzymes in Organic Synthesis as Bio-catalysis.**	▪Five hours/week lectures. ▪Group Discussion on bio-catalysis using available references (SDL) ▪Open Discussion.	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.4	**To state the Reaction catalyzed by enzymes types.**	▪ Five hours/week lectures. ▪ Group Discussion using available references (SDL)	▪ Assignments ▪ Open Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
2.0	**Skills**		
2.1	**To explain the role of Enzymes as a Catalyst in Chemical Reaction**	▪ Lectures activity. ▪ Self-study ▪ Deep discussion on strategies for using enzymes as a catalyst in chemical reaction.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation. ▪ Mini -seminar.
2.2	**To justify Prodrug and Drug Delivery Systems in actions.**	▪ Introduce some Prodrug and drug delivery examples and its action mechanism .for discussions. ▪ Self-study ▪ Brainstorming.	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion ▪ Short Quizzes.

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
2.3	**To outline the advantage of Bio-catalysis in Organic Synthesis.**	▪ Lectures ▪ Oral Discussions. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion. ▪ Participation.
2.4	**To predict the role of Enzymes in Organic Synthesis, Reaction Mechanisms and its applications, and writing of mini-Reports, operating electronic mail, and Network in communicating with others.**	▪ Group Discussion and Assignments ▪ Introduce several examples for catalyzed reaction by enzymes and co-enzymes, which will require reading, writing, and oral presentation. ▪ 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**		
3.1	**To demonstrate scientific research, independently and collaborate with groups in relevant topics.**	▪ Brainstorming. ▪ Exercises ▪ Group Discussion. ▪ Team work.	▪ Oral Discussion. ▪ Group Discussion. ▪ Assignments.
3.2	**To use his/her capability to be an effective and active collaborator with inter-professionalism in research team , to develop knowledge, and enhance society's quality as well as independently.**	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	**Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)**	**weekly**	**30 %**
2	**Midterm Exam**	**7th week**	**30 %**
3	**Final Exam**	**13th week**	**40 %**
4	**Total**		**100%**

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice: • **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;** • **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.** • **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.** • **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***An introduction to Medicinal Chemistry,*** Graham L. Patrick, 5th Edition, Oxford University Press, 2013. ISBN 978-0-19-969739-7 ***The organic chemistry of drug design and drug Action***, Richard B. Silverman, 2nd Edition, Academic Press, 2004. ISBN : 0-12-643732-7 ***Organic Chemistry of Enzyme-Catalyzed Reactions,*** Richard B. Silverman, 2nd Edition, Academic Press, 2002. ISBN : 9780126437317
Essential Reference Materials	***Bioorganic Chemistry: Highlights and New Aspects***, U. Diederichsen, T. K. Lindhorst, B. Westermann , L. A. Wessjohann, Wiley-VCH, (1999), ISBN: 978-3-527-29665-1.
Electronic Materials	• Bioorganic & Medicinal Chemistry Letters • Bioorganic & Medicinal Chemistry • Tetrahedron • Tetrahedron Letters • Tetrahedron asymmetry • Bioorganic Chemistry. • Saudi Digital Library
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites.

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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.
	Course Responsible	**Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	Council of Chemistry Department
Reference No.	10 (No. 2/10)
Date	21/04/1444- 15/11/2022

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Chemistry of Organic Polymers and Petrochemicals**
Course Code:	**CHM 6226**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: **5 (5 Lectures, 0 Lab, 0 Tutorials)**	
2. Course type ☐ Required ☒ Elective	
3. Level/year at which this course is offered: **Level 5/Year 2**	
4. Pre-requisites for this course (if any): **Advanced Organic Chemistry – CHM 6121**	
5. Co-requisites for this course (if any): **None**	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

This course covers selected special topics pertinent to research in polymer sciences and petrochemicals, covering the synthesis and properties of polymers, polymer forming processes, polymers applications and petrochemicals.

2. Course Main Objective

At the end of the course, the students will be able to:

- Develop an advanced understanding of organic polymer synthesis and relevant technology used.
- Outline the polymer synthesis methods and modification or additives occurred.
- Account for different classes of additives impact mechanisms.
- Recognize the reaction mechanisms of polymerization process.
- Choose analytical methods to characterize and interpret the polymerization reaction and the product.
- Be familiar with structure, mechanical properties of polymers.
- Summarize and account for Polymers for Advanced Technologies and Polymer Nanocomposites.

3. Course Learning Outcomes

	CLOs *After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recognize advanced Organic Synthesis of Polymers and Polymerization steps.	K1. *Org.*; K2. *Org.* K3. *Org.*
1.2	To memorize the characterization and properties of Polymer Spectroscopically, Analytically and Mechanically.	K1. *Org.*; K2. *Org.* K4. *Org.*
1.3	To outline Advanced Technology of Polymers, Polymer Nano-Composites and its impact in industry and life	K1. *Org.*; K2. *Org.* K3. *Org.*
1.4	To state Feedstock Composition and Properties of Petrochemicals	K3. *Org.*; K4. *Org.*
2	**Skills:**	
2.1	To analyze the isolated results of spectroscopy, analytical and mechanical measurements.	S1. *Org.*; S2. *Org.* S3. *Org.*
2.2	To compare between polymerization types and the mechanical properties of isolated polymers	S1. *Org.*; S2. *Org.*
2.3	To summarize advanced technology and application of polymers and its impact in industry and life	S1. *Org.*; S2. *Org.*
2.4	To interpret the differentiation of the polymerization reactions techniques and their applications, with the writing of mini- Reports, operating electronic mail, and Networks in communicating with others.	S1. *Org.*; S3. *Org.* S4 *Org.*
3	**Values:**	
3.1	To judge a scientific presentation, and work independently or with other groups on relevant topics, using IT to analyze, and communicate information.	V1. *Org.* .
3.2	To show his/ her ability to be an effective collaborator and inter-professionalism in class discussions or team works, as well as independently.	V1. *Org.*; V2. *Org.*

C. Course Content

No	List of Topics	Contact Hours
1	***Recall Basic Concepts*:** Polymer Types, Classification of Polymers, Nomenclature, Polymer States and Properties.	**5**
2	***POLYMER SYNTHESIS AND MODIFICATION, Step-Growth Polymerization*:** Polymerization Kinetics, Inorganic Condensation Polymers, Dendrimers, Thermoset Polycondensation Polymers, Controlled Molecular Weight Condensation Polymers.	**5**
3	***Free Radical Polymerization:*** Basic Mechanism, Other Free Radical Reactions, Kinetics and Polymerization Rate, Molecular Weight and Molecular Weight Distribution, Controlled Radical Polymerization**.**	**5**
4	***Coordination Polymerization:*** Polymer Types, Catalyst Types, Coordination Polymerization Mechanism**.** ***Copolymerization:*** Types of Copolymers, Copolymer Composition, Reaction Conditions**.**	**5**
5	***Anionic Polymerization:*** Living Anionic Polymerization, General Considerations, Kinetics and Mechanism of Polymerization, Stereochemistry, Copolymerization of Styrenes and Dienes, Synthetic Applications of Living Anionic Polymerization.	**4**
6	***Cationic Polymerizations:*** Carbo-cationic Polymerization, Cationic Ring-Opening Polymerization. ***Crosslinking:*** Background on Polymer Networks, Main Chemical Routes for Synthesis of Polymer Networks, Characterization of Polymer Networks and Gels.	**3**
7	***Polymer Additives:*** Antioxidants, PVC Heat Stabilizers, Light Stabilizers, Flame Retardants, Plasticizers, Scavenging Agents, Additives to Enhance Processing, Additives to Modify Plastic Surface Properties, Additives to Modify Polymer Chain Structures, Additives to Influence Morphology and Crystallinity of Polymers, Antimicrobials, Additives to Enhance Thermal Conductivity, Active Protection Additives, Animal Repellents, Markers, Blowing Agents, Trends in Polymer Additives	**7**
8	***New Polymerization Processes:*** Polymerizations in Benign or Green Solvents, Alternative Energy Sources for Polymerization Processes, Polymerization in Micro reactors	**3**
9	***Polymer Spectroscopy and Compositional Analysis:*** Elemental Analysis, Infrared Spectroscopy, Nuclear Magnetic Resonance of Polymers in Solution, Mass Spectrometry. ***Small-Angle X-Ray Scattering of Polymer Systems*:** Polymer Morphology, Small-Angle X-Ray Scattering, Analysis in Reciprocal Space, Analysis in Real Space.	**5**
10	***Structure and Mechanical Properties of Polymers*:** Structure of Polymer Chains, Mechanical Properties of Polymers, Mechanical Properties of Polymer Composites.	**3**
11	***Principles of Polymer Processing:*** Compounding, Extrusion, Bottle Blowing, Injection Molding**.** ***Polymer Blends:*** Miscibility in Polymer Blends, Compatibility in Polymer Blends, Preparation of Polymer Blends, Factors Influencing the Morphology of a Polymer Blend, Properties of Polymer Blends, Applications of Polymer Blends**.**	**4**
12	***POLYMERS FOR ADVANCED TECHNOLOGIES, Conducting Polymers*:** The Structures of Conducting Polymers, Charge Storage, Doping, Charge Transport, Syntheses, Conducting Polymers.	**3**

13	***Dendritic Polymers:*** Dendrimers, Hyper branched Polymers, Dendri graft Polymers. ***Polymer Nanocomposites:*** Polyester/Clay Nanocomposites, Polyolefin/Clay Nanocomposites, Polystyrene/Clay Nanocomposites, Polymer/Carbon Black Nanocomposites, Nanoparticles of Barium Sulfate, Polymer/Graphene Nanocomposites.	**4**
14	**PETROCHEMICALS** ***The Petrochemical Industry:*** The Petrochemical Industry, Petrochemicals, Primary Petrochemicals, Products and End Use, Production of Petrochemicals. ***Feedstock Composition and Properties:*** Natural Gas, Composition and Properties, Natural Gas Liquids, Gas Condensate, Gas Hydrates, Other Types of Gases, Biogas, Coalbed Methane, Coal Gas, Geopressurized Gas, Landfill Gas, Refinery Gas, Synthesis Gas, Tight Gas, Petroleum, Composition and Properties., Opportunity Crude Oil, High Acid Crude Oil, Foamy Oil, Tight Oil, Other Petroleum-Derived Feedstocks, Naphtha, Kerosene, Fuel Oil, Gas Oil.	**4**
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
1.0	**Knowledge and Understanding**		
1.1	**To recognize Advanced Organic Synthesis of Polymers and Polymerization steps.**	▪ Five hours/week lectures. ▪ Self-study ▪ Homework.	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion ▪ Participation.
1.2	**To memorize the characterization and properties of Polymer Spectroscopically, Analytically and Mechanically.**	▪ Five hours/week lectures. ▪ Think, and justify the full characterization and properties of polymer, using available references (SDL) online. ▪ Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.3	**To outline Advanced Technology of Polymers, Polymer nano-composites and its impact in industry and life.**	▪ Five hours/week lectures. ▪ Group Discussion on advanced technology of polymers and impact on KSA using available references online using available references (SDL)	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.4	**To state Feedstock Composition and Properties of Petrochemicals.**	▪ Five hours/week lectures. ▪ Group Discussion using available references (SDL.	▪ Assignments ▪ Open Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
2.0	**Skills**		
2.1	**To analyze the isolated results of spectroscopy, analytical and mechanical measurements.**	▪ Lectures activity ▪ Self-study ▪ Deep discussion on isolated polymers analysis.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation ▪ Mini -seminar.
2.2	**To compare between polymerization types and the mechanical properties of isolated polymers.**	▪ Practice on polymer types its mechanical properties. ▪ Brainstorming. ▪ Self-study.	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion. ▪ Short Quizzes.

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
2.3	To summarize advanced technology and application of polymers and its impact in industry and life.	▪ Lectures ▪ Oral Discussions. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion. ▪ Participation.
2.4	To interpret the differentiation of the polymerization reactions techniques and their applications, with the writing of mini- Reports, operating electronic mail, and Networks in communicating with others.	▪ Group Discussion and Assignments ▪ Introduce several examples for polymerization reactions techniques and its applications, which will require reading, writing, and oral presentation. ▪ 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**		
3.1	To judge a scientific presentation, and work independently or with other groups on relevant topics, using IT to analyze, and communicate information.	▪ Brainstorming. ▪ Exercises ▪ Group Discussion. ▪ Team work.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	To show his/ her ability to be an effective collaborator and inter-professionalism in class discussions or team works, as well as independently.	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects.	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)	weekly	30 %
2	Midterm Exam	7th week	30 %
3	Final Exam	13^{th} week	40 %
4	Total		100%

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice: • **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;** • **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.** • **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.** • **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***Handbook of Polymer Synthesis, Characterization, and Processing,*** Saldívar-Guerra, E.; Vivaldo-Lima, E John Wiley & Sons, Inc., 2013. ISBN: 9780470630327. ***Handbook of Petrochemical Processes***, James G. Speight, Taylor Francis. 2019. ISBN: 9780429155611.
Essential Reference Materials	***Introduction to Polymer Science and Chemistry: A Problem Solving Approach***, M. Chanda, CRC Press, (2013). ISBN 9781466553842 - CAT# K15289 ***Textbook of Polymer Science***, F. W. Billmeyer, 3rd Ed., Wiley-Interscience, (1984). ISBN: 978-0-471-03196-3 ***Polymer Science and Technology***, J. R. Fried, , 2nd Ed., Prentice-Hall, (2003). ISBN-10: 0137039557
Electronic Materials	• Progress in Polymer Science • Polymer Chemistry • European Polymer Journal • Journal of Polymer Science, Part A: Polymer Chemistry • Saudi Digital Library
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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	

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Physical Organic Chemistry**
Course Code:	**CHM 6122**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: 5 (5 Lectures, 0 Lab, 0 Tutorials)	
2. Course type ☐ Required ☒ Elective	
3. Level/year at which this course is offered: Level 3/Year 1	
4. Pre-requisites for this course (if any): Advanced Organic Chemistry – CHM 6121	
5. Co-requisites for this course (if any): None	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

The course covers selected special topics pertinent to current research in physical organic chemistry. Topics include molecular structure and thermodynamics, reactivity and mechanisms, stereochemistry and electronic structure.

2. Course Main Objective

- Understand the detailed structure of a molecule.
- Identify a molecule's hot spots with respect to reactivity (factors include sites of acidity, electronegativity, polarizability, atomic and molecular orbital character and strain).
- Evaluate the contribution of these factors to a molecule’s energetics, noncovalent interactions and reaction mechanisms.
- Be familiar with molecular structure and thermodynamics, reactivity relationships.
- Recognize stereochemistry and electronic structures influences on the reaction mechanisms.

3. Course Learning Outcomes

CLOs	*After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recall knowledge of Molecular Structure and Thermodynamics	K1. *Org.*; K2. *Org.*; K4. *Org.*
1.2	To outline the chemical bonding and molecular structures in Organic Chemistry Reactions.	K1. *Org.*; K2. *Org.*; K4. *Org.*
1.3	To describe Molecular Recognition and Supramolecular Chemistry.	K1. *Org.*; K2. *Org.*; K3. *Org.*
1.4	To state a molecule's hot spots with respect to reactivity.	K2. *Org.*; K3. *Org.*
2	**Skills:**	
2.1	To evaluate knowledge and understanding of concepts and principles of Physical Organic Chemistry.	S1. *Org.*; S2. *Org.*; S3. *Org.*
2.2	To analyze problems and explore strategies for their solution, with justify the optimum approaches to appropriate reaction mechanism.	S2. *Org.*; S4. *Org.*
2.3	To justify Organic chemical information interpreting to predict and postulate the Organic Reaction Mechanism support a reasonable arguments.	S2. *Org.*; S3. *Org.*
2.4	To illustrate the reactivity and mechanisms of organic molecules and its applications, accompanying writing of mini-Reports, operating electronic mail, and Network in communicating with others.	S1. *Org.*; S3. *Org.*; S4. *Org.*
3	**Values:**	
3.1	To judge a scientific presentation and scientific projects, and work independently or with other groups on relevant topics, to exchange information	V1. *Org.*
3.2	To appraise effectively the collaboration and inter-professionalism in class discussions or team works, as well as independently.	V1. *Org.*; V2. *Org.*

C. Course Content

No	List of Topics	Contact Hours
1	***Molecular Structure and Thermodynamics***	
1.1	***Introduction to Structure and Models of Bonding***: Review on Basic bonding concept, Modern theory of organic bonding, Bonding and structures of reactive intermediates	**10**
1.2	***Strain and Stability:*** Thermochemistry of stable molecules and reactive intermediates, Relationships between structure and energetic-Basic conformational analysis, Electronic effects, highly strained molecules, Molecular mechanics.	**10**
1.3	***Solutions and Non-Covalent Binding Forces:*** Solvent and solution properties (Dielectric constant, solubility, Solute mobility, The thermodynamics of solutions), Binding forces.	**5**
1.4	***Molecular Recognition and Supramolecular Chemistry:*** Thermodynamic Analyses of Binding phenomena.	**5**
1.5	***Stereochemistry:*** Symmetry and Stereochemistry, Topicity relationships (Homotopic, Enantiotropic and Diastereotropic), Stereoselectivity and Sterospecificity.	**4**
2	***Reactivity, Kinetics, and Mechanisms***	
2.1	***Energy Surfaces and Kinetic Analyses:*** Energy surfaces and related concepts, Postulates and principles related to kinetic analysis (The Hammond Postulate, The reactivity vs Selectivity principle, Kinetic vs Thermodynamic control).	**3**
2.2	***Catalysis:*** General Principles of catalysis, Bronsted Acide-Base catalysis, Enzymatic catalysis.	**3**
2.3	***Organic Reaction Mechanisms:*** Part 1. Reactions Involving Additions and/or Eliminations, Part 2. Substitutions and Thermal Isomerizations/Rearrangements.	**4**
2.4	***Organo-transition Metal Reaction (Mechanisms and Catalysis):*** Common Organometallic Reactions**.**	**3**
3	**Electronic Structure: Theory and Applications**	
3.1	***Advanced Concepts in Electronic Structure Theory:*** Introductory Quantum Mechanics, Solving the Schrodinger equation for complex systems, Organometallic complexes.	**7**
3.2	***Thermal Pericyclic Reactions:*** Cycloaddition, Analysis of two simple cycloadditions, Electrocyclic reactions, Sigmatropic rearrangements**.**	**3**
3.3	***Photochemistry:*** Photo-physical processes, Photochemical Reactions	**3**
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	**To recall knowledge of Molecular Structure and Thermodynamics.**	▪ Five hours/week lectures. ▪ Self-study ▪ Homework	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion ▪ Participation.
1.2	**To outline the chemical bonding and molecular structures in Organic Chemistry Reactions.**	▪ Five hours/week lectures. ▪ Think, to justify the chemical reaction mechanism, using available references (SDL) online. ▪ Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.3	**To describe Molecular Recognition and Supramolecular Chemistry.**	▪ Five hours/week lectures. ▪ Group Discussion using available references (SDL) online.	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.4	**To state a molecule's hot spots with respect to reactivity.**	▪ Five hours/week lectures. ▪ Group Discussion using available references (SDL) online	▪ Assignments ▪ Open Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
2.0	**Skills**		
2.1	**To evaluate knowledge and understanding of concepts and principles of Physical Organic Chemistry.**	▪ Lectures activity. ▪ Self-study ▪ Deep discussion on Physical Organic Chemistry concepts.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation ▪ Mini -seminar.
2.2	**To analyze problems and explore strategies for their solution, with justifying the optimum approaches to appropriate reaction mechanism.**	▪ Practice some reaction examples by proposing the Reaction Mechanism achieving. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion ▪ Short Quizzes.
2.3	**To justify Organic Chemical Information Interpreting to predict and postulate the Organic Reaction Mechanism support a reasonable arguments.**	▪ Lectures ▪ Oral Discussions. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion. ▪ Participation.

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
2.4	**To illustrate the reactivity and mechanisms of organic molecules and its applications, accompanying writing of mini-Reports, operating electronic mail, and Network in communicating with others.**	▪ Group Discussion and Assignments ▪ Suggest several examples for reactivity and mechanisms of organic molecules, which will require reading, writing, and oral presentation. ▪ 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**		
3.1	**To judge a scientific presentation and scientific projects, and work independently or with other groups on relevant topics, to exchange information**	▪ Brainstorming. ▪ Exercises ▪ Group Discussion. ▪ Team work.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	**To appraise effectively the collaboration and inter-professionalism in class discussions or team works, as well as independently.**	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	**Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)**	**weekly**	**30 %**
2	**Midterm Exam**	**7th week**	**30 %**
3	**Final Exam**	**13th week**	**40 %**
4	**Total**		**100%**

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice:

- **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;**
- **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.**
- **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.**
- **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***Advanced Organic Chemistry, Part A: Structure and Mechanisms,*** F. A. Carey; R. J. Sundberg (2007), Fifth edition, Springer US. ISBN 13: 9780387448978. ***Modern physical organic chemistry,*** E.V. Anslyn, D. A. Dougherty (2005). ISBN: 978- 1891389313. ***Organic chemistry: Theory, reactivity, and mechanisms in modern synthesis***, P. Vogel, K.N. Houk (2019). ISBN: 978-3527345328.
Essential Reference Materials	***MARCH'S Advanced Organic Chemistry, Reactions, Mechanisms, and Structure***, Michael B. Smith, Jerry March, John Wiley & Sons, Inc., 7th Ed., 2007. ISBN: 978-0-470-46259-1
Electronic Materials	• Journal of Organic Chemistry, ACS • Organic Letters, ACS • Tetrahedron • Tetrahedron Letters • Organic and Biomolecules Chemistry, RSC • European Journal Of Organic Chemistry • Saudi Digital Library
Other Learning Materials	• Blackboard. • Multimedia associated with the text book and the relevant websites.

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio.

Evaluation Areas/Issues	Evaluators	Evaluation Methods
		Indirect: Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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	

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Selected Topics in Organic Chemistry**
Course Code:	**CHM 6227**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: **5 (5 Lectures, 0 Lab, 0 Tutorials)**	
2. Course type ☐ Required ☒ Elective	
3. Level/year at which this course is offered: **Level 5/Year 2**	
4. Pre-requisites for this course (if any): **Advanced Organic Chemistry – CHM 6121**	
5. Co-requisites for this course (if any): **None**	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

The course covers selected topics in Organic Chemistry suggested by CGC forward to the approved by the head of department and the department council each time this course is offered.

2. Course Main Objective

At the end of the course, the students will be able to:

- Enable students to enrich their knowledge with special topics of interest, carefully selected from Organic Chemistry topics. The course covers selected topics in Organic chemistry suggested by the Organic Chemistry division and approved by the head of the department and the department council each time this course is offered.
- Learn topics those are not formally offered by the program and receive appropriate academic credit
- Recognize the hot topics in the Organic chemistry.

3. Course Learning Outcomes

	CLOs	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To be specified according to the selected topics	Depending on.
1.2		
1.3		
1.4		
2	**Skills:**	
2.1	To be specified according to the selected topics	Depending on.
2.2		
2.3		
2.4		
3	**Values:**	
3.1	To be specified according to the selected topics	Depending on.
3.2		

C. Course Content

No	List of Topics	Contact Hours
1	Specific to recent Selected topics in Organic Chemistry	60
2		
3		
4		
5		
6		
	Total	**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
1.0	Knowledge and Understanding		
1.1-1.4	To be specified according to the selected topics		
2.0	Skills		
2.1-2-4	To be specified according to the selected topics		
3.0	Values		
3.1- 3.2	To be specified according to the selected topics		

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)	weekly	30 %
2	Midterm Exam	7th week	30 %
3	Final Exam	13th week	40 %
4	Total		100%

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice:

- **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;**
- **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.**
- **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.**
- **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	To be specified according to the selected topics
Essential Reference Materials	• To be specified according to the selected topics • Saudi Digital Library
Electronic Materials	• To be specified according to the selected topics
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites.

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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	

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Spectroscopic Methods for Determining Organic Compounds Structures**
Course Code:	**CHM 6123**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: **5 (3 Lectures, 0 Lab, 0 Tutorials)**	
2. Course type ☐ Required ☒ Elective	
3. Level/year at which this course is offered: **Level 3/Year 1**	
4. Pre-requisites for this course (if any): **Advanced Organic Chemistry – CHM 6121**	
5. Co-requisites for this course (if any): **None**	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

This course was designed to lead students to a gain a good insight into the various spectroscopic characterization techniques for organic compounds structure determination. These spectroscopic techniques include infrared (IR), nuclear magnetic resonance (NMR) and mass spectroscopy (MS). The focus on theories and applications of the previously mentioned techniques combined with tutorials provides students with the required platform for solving problems related to structure elucidation of the organic compounds.

2. Course Main Objective

At the end of the course, the students will be able to:

- Use spectroscopic equipment such as IR, NMR (^{1}H and ^{13}C) in all techniques used, MS. Spectrometers.
- Identify organic compounds by analysis and interpretation of spectral data.
- Analyze and interpret One- Dimensional NMR (^{1}H and ^{13}C), and Two-Dimensional NMR spectra and relevant techniques used.
- Investigate and determine the structure of typical organic chemical compounds using mass spectroscopy supported by NMR (^{1}H and ^{13}C), and IR.
- Perform the most commonly mass spectroscopy analysis and fragmentation process in Electron Ionization Mass Spectrometry, and to interpret and the result.

3. Course Learning Outcomes

	CLOs *After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recall Spectroscopic Elucidation of Organic Molecules.	K1. *Org.*; K2. *Org.*; K3. *Org.*
1.2	To describe the full characterization of spectroscopic data of organic compounds.	K2. *Org.*; K3. *Org*; K4. *Org.*
1.3	To outline reasonable appropriate arguments and interpretation for identifying and elucidating organic compounds.	K2. *Org.*; K4. *Org.*
1.4	To state Specific Techniques and experimental tools for Spectroscopic Elucidation of Complex Organic Molecules.	K3. *Org*; K4. *Org.*
2	**Skills:**	
2.1	To analyze One- Dimensional NMR (^{1}H and ^{13C}), and Two-Dimensional NMR spectra and relevant techniques used.	S1. *Org.*; S2. *Org.*; S3. *Org.*
2.2	To justify the appropriate techniques and experiments in NMR for identifying a complex organic structure.	S2. *Org.*; S3. *Org.*
2.3	To summarize elucidation of chemical structures to organize thinking, evaluate and identify the chemical structures correctly.	S2. *Org.*; S3. *Org.*
2.4	To explain and solving spectroscopic elucidation problems of organic molecules, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.	S1. *Org.*; S2. *Org.*; S4. *Org.*
3	**Values:**	
3.1	To judge a scientific presentation and scientific projects, and work independently or with other groups on relevant topics, to exchange information	V1. *Org.*
3.2	To use all information gained effectively, with research team in class discussions or team works, as well as independently.	V1. *Org.*; V2. *Org.*

C. Course Content

No	List of Topics	Contact Hours
1	***Recall Spectroscopic Elucidation of Simple Organic Molecules:*** Infrared Spectroscopy Proton Nuclear Magnetic Resonance, 13C nuclear Magnetic Resonance, Simple Examples.	**5**
2	***Further Topics in One- Dimensional NMR Magnetic:*** Shielding, Relaxation Effects of Relaxation and NOE on Peak Intensities, Common Impurities in NMR spectra, Other Useful Nuclei, Factors that Determine Chemical Shifts, Interpretation and Use of Proton and Carbon Coupling Constants, Using Coupling Constants to Make Configuration Assignments, The Nuclear Overhauser Effect.	**10**
3	***Multiple-Pulse and Multidimensional NMR Techniques:*** A Glimpse of Multiple-Pulse NMR Methods, Elements of Multiple- Pulse NMR, Two-Dimensional NMR Techniques, Using Two-Dimensional NMR in Assigning Spectra, Strategic for Using 2D NMR in structure Determination, Use of NOESY and ROESY to Determine Relative Stereochemistry and Conformations, Configurational Analysis Based on Coupling Constants, Homonuclear correlated spectroscopy (COSY); Proton detected heteronuclear multiquantum coherence (HMQC), Heteronuclear Multi-Bond Connectivity (HMBC).	**10**
4	***Carbon-13 Nuclear Magnetic Resonance Spectroscopy:*** Experimental Aspects of Carbon-13 Nuclear Magnetic Resonance Spectroscopy, Gated Decoupling, Assignment Techniques, Multiplicity Selection with the Heteronuclear Spin Echo Experiment Heteronuclear Two-Dimensional ^{1}H,^{13}C Chemical Shift Correlation, The ^{13}C,^{13}C INADEQUATE Experiment, Heteronuclear *J*, δ Spectroscopy, Carbon-13 Chemical Shifts Carbon-13 Spin–Spin Coupling Constants, Carbon-13 Coupling Constants and Chemical Structure, ^{13}C,^{13}C Coupling Constants, ^{13}C, ^{1}H Coupling Constants, ^{13}C,X Coupling Constants.	**15**
5	***Mass Spectroscopy:*** A Glimpse of Mass Spectrometry, Isotopes, Atomic Composition, Molecular Formulas, and Ionic Mass; Low and High Resolution and Measurments.	**5**
6	***Mass Spectrometry Analysis of Small and Large Molecules:*** A Glimpse of Molecular Ions Revisited, Small-Molecule Mass Spectral Analysis, Large-Molecule Mass Spectral Analysis.	**5**
7	***Fragmentation Processes in Electron Ionization Mass Spectrometry:*** Interpreting a low Resolution Electron Ionization Mass Spectrum, Fragmentation Process, Identification of Functionality from Fragmentation Process, Schematic Approach for Interpretation of an EIMS.	**10**
		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
1.0	Knowledge and Understanding		
1.1	To recall Spectroscopic Elucidation of Organic Molecules.	▪ Five hours/week lectures. ▪ Self-study ▪ Homework.	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion ▪ Participation.
1.2	To describe the full characterization of spectroscopic data of organic compounds.	▪ Five hours/week lectures. ▪ Think, and justify the chemical structures spectroscopically, using available references (SDL) online. ▪ Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.3	To outline reasonable appropriate arguments and interpretation for identifying and elucidating organic compounds.	▪ Five hours/week lectures. ▪ Group Discussion using available references (SDL)	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.4	To state Specific Techniques and experimental tools for Spectroscopic Elucidation of Complex Organic Molecules.	▪ Five hours/week lectures. ▪ Group Discussion using available references (SDL)	▪ Assignments ▪ Open Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
2.0	Skills		
2.1	To analyze One- Dimensional NMR (^{1}H and ^{13}C), and Two-Dimensional NMR spectra and relevant techniques used.	▪ Lectures activity. ▪ Practice on some examples by elucidation and justification the chemical structures. ▪ Self-study.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation ▪ Mini -seminar.
2.2	To justify the appropriate techniques and experiments in NMR for identifying complex organic structures.	▪ Lectures and Oral Discussions. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion ▪ Short Quizzes and Exams.
2.3	To summarize elucidation of chemical structures to reorganize thinking, evaluate and identify the chemical structures correctly.	▪ Lectures ▪ Group Discussions. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Participation

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
2.4	**To explain and solving spectroscopic elucidation problems of organic molecules, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others..**	▪ Group Discussion and Assignments ▪ Introduce several examples of organic molecules to elucidate and justify spectroscopically, which will require reading, writing, and oral presentation. ▪ 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		
3.1	**To judge a scientific presentation and scientific projects, and work independently or with other groups on relevant topics, to exchange information**	▪ Brainstorming. ▪ Exercises ▪ Group Discussion. ▪ Team work.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments
3.2	**To use all information gained effectively, with research team in class discussions or team works, as well as independently.**	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	**Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)**	**weekly**	**30 %**
2	**Midterm Exam**	**7th week**	**30 %**
3	**Final Exam**	**13th week**	**40 %**
4	**Total**		**100%**

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice: • **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;** • **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.** • **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.** • **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***Spectroscopic Techniques in Organic Chemistry***, Williams, D. H. Fleming, I. , 6th , McGraw-Hill, Londen, 2007. ISBN-13: 978-0077118129. ***Basic One- and Two-dimensional NMR Spectroscopy***, Friebolin, H. Wiley-VCH, Weinheim, 2010. ISBN-10: 3-527-31233-1, ISBN-13: 978-3-527-31233-7. ***NMR Spectroscopy: Basic Principles, Concepts, and Applications in Chemistry***, Günther, H, 2nd Edition, John Wiley & Sons, 2013. ISBN: 978-0-471-95201-5
Essential Reference Materials	**NONE**
Electronic Materials	• Journal of Organic Chemistry, ACS • Organic Letters, ACS • Tetrahedron • Tetrahedron Letters • Organic and Biomolecules Chemistry, RSC • European Journal Of Organic Chemistry
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites.

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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.
	Course Responsible	**Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Stereoselectivity Synthesis**
Course Code:	**CHM 6224**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: **5 (5 Lectures, 0 Lab, 0 Tutorials)**	
2. Course type ☐ Required ☒ Elective	
3. Level/year at which this course is offered: **Level 4/Year 2**	
4. Pre-requisites for this course (if any): **Advanced Organic Chemistry – CHM 6121**	
5. Co-requisites for this course (if any): **None**	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

This course is designed to provide an advanced understanding of structure and stereoisomers, configuration, and stereochemistry of alkenes. The course will extend to cover conformation of cyclic and acyclic molecules, and Stereoselectivity Synthesis. This part will dedicated to Terminology, Stereoselective Synthesis, Categories of Stereoselective Synthesis, Stereoselective Catalytic Reductions, Homogeneous and Heterogeneous Catalytic Reductions, Stereoselective Non-Catalytic Reductions, Enantioselective Non-Catalytic Reductions, and others of interest in this topics.

2. Course Main Objective

At the end of the course, the students will be able to:

- Develop a fundamental understanding of stereochemistry and all aspects relevant for structure, and stereoisomer.
- Outline the basic chemo-, regio- and stereochemical concepts.
- Be familiar with principles for selective synthesis for stereoselective synthesis.
- Identify suitable reagents for selective transformations.
- Suggest methods for selective synthesis of simple organic compounds, also containing stereogenic elements.

3. Course Learning Outcomes

CLOs	*After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recall stereoisomers symmetry and configurations of organic compounds.	K1. *Org.*; K2. *Org.*; K4. *Org.*
1.2	To outline stereochemistry of alkenes and conformation of acyclic and Cyclic Organic Molecules.	K2. *Org.*; K4. *Org*
1.3	To list Categories and principles of Stereoselective Synthesis.	K2. *Org.*; K3. *Org.*; K4. *Org*
1.4	To state Stereo- selective synthesis of Simple Organic Compounds.	K3. *Org.*; K4. *Org*
2	**Skills:**	
2.1	To analyze problems and explore strategies for a suitable solution, justifying the optimum approaches to appropriate Stereoselective Synthesis.	S1. *Org.*; S2. *Org.*; S3. *Org.*
2.2	To interpret Stereochemical information for isolated reaction product leading to predict and postulate the Stereoselectivity Synthesis mechanism.	S2. *Org.*; S3. *Org*
2.3	To justify the methods for selective synthesis of organic compounds containing Stereogenic Elements.	S1. *Org.*; S2. *Org*; S3. *Org*
2.4	To evaluate all aspects of Stereoselective Synthesis, and its applications, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others	S1. *Org.*; S3. *Org*; S4. *Org.*
3	**Values:**	
3.1	To show a scientific presentation research, and work independently and integrate with a collaborated group in relevant topics, using IT to analyze, and communicate information.	V1. *Org.*; V2. *Org.*
3.2	To appraise effectively the collaboration and inter-professionalism in class discussions or team works, as well as independently.	V1. *Org.*; V2. *Org.*

C. Course Content

No	List of Topics	Contact Hours
1	***Introduction and Structure:*** Scope, Polarimetry and Optical Rotation, Constitution, Configuration, Conformation, Determination of Structure, Molecular Models. Stereoisomers: Nature of Stereoisomers, Enantiomers, Diasteriomers	**5**
2	***Stereoisomers:*** Nature of Stereoisomers, Enantiomers, Diasteriomers.	**5**
3	***Symmetry:*** Symmetry of Elements, Symmetry Operators, Point Groups Cntaining Chiral Molecules, Point Groups Containing Only Achiral Molecules, Desymmetrization, Symmetry and Molecular Properties.	**10**
4	***Configuration:*** Definitions, Relative and Absolute Configuration, Absolute Configuration and Notation, Determination of Relative Configuration of Saturated Aliphatic Compounds.	**10**
5	***Stereochemistry of Alkenes:*** Structure of Alkenes. Nature of cis-trans Isomerism, Determination of Configuration of cis-trans, Interconversion of cis-trans Isomers.	**7**
6	***Conformation of Acyclic Molecules:*** Conformation of Ethane, Butane and other Simple Saturated Acyclic Molecules, Conformation of Acyclic and Miscellaneous Compounds.	**7**
7	***Conformation of Cyclic Molecules:*** Stereisomerism and Configuration Nomenclture of Ring Compounds, Stability of Cyclic Molecules, Conformational Aspects of The Chemistry of Six Membered Ring Compounds, Stereochemistry of Ring Compounds Other Than Six Membered Ring, Stereochemistry of Fused, Bridged and Caged Ring Systems .	**6**
8	***Stereoselective Synthesis:*** Terminology, Stereoselective Synthesis, Categories of Stereoselective Synthesis, Stereoselective Catalytic Reductions, Homogeneous and Heterogeneous Catalytic Reductions, Stereoselective Non-Catalytic Reductions, Enantioselective Non-Catalytic Reductions, Diastereoselective Non-Catalytic Reductions, Stereoselective Carbon-Carbon Bond Forming Reactions, Nucleophilic Additions to Aldehydes and Ketones, Asymmetric Catalytic Hydro-carbonylations, Asymmetric Aldol Reactions, Asymmetric Alkylation Reactions, Asymmetric Carbon-Heteroatom Bond Formations, Carbon-Oxygen Bond Formation, Carbon-Nitrogen Bond Formation, Carbon Sulfur Bond Formation, Stereoselective C-H Bond Formation and Proton Migration.	**10**
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	**To recall Stereoisomers Symmetry and Configurations of Organic Compounds.**	▪ Five lectures. ▪ Self-study ▪ Homework	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion ▪ Participation.
1.2	**To outline Stereochemistry of Alkenes and conformation of Acyclic and Cyclic Organic Molecules.**	▪ Five hours/week lectures. ▪ Think and justify stereochemistry of alkenes acyclic and cyclic confirmation, using available references (SDL) online. ▪ Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.3	**To list Categories and principles of Stereoselective Synthesis**	▪ Five hours/week lectures. ▪ Group Discussion using available references (SDL).	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.4	**To state Stereoselective Synthesis of Simple Organic Compounds.**	▪ Five hours/week lectures. ▪ Group Discussion using available references (SDL).	▪ Assignments ▪ Open Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
2.0	**Skills**		
2.1	**To analyze problems and explore strategies for a suitable solution, justifying the optimum approaches to appropriate Stereoselective Synthesis.**	▪ Lectures activity. ▪ Self-study ▪ Deep discussion on appropriate strategies for stereo-selective synthesis.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation ▪ Mini -seminar.
2.2	**To interpret Stereochemical information for isolated reaction product leading to predict and postulate the Stereoselectivity Synthesis Mechanism.**	▪ Practice some stereoselective synthesis examples by proposing the reaction mechanism achieving. ▪ Brainstorming. ▪ Self-study.	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion ▪ Short Quizzes

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
2.3	**To justify the methods for Selective synthesis of organic compounds containing Stereogenic Elements.**	▪ Lectures ▪ Oral Discussions. ▪ Brainstorming. ▪ Self-study.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion. ▪ Participation.
2.4	**To evaluate all aspects of Stereoselective Synthesis, and its applications, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.**	▪ Group Discussion and Assignments ▪ Introduce several examples for some organic compounds synthesized by stereoselective synthesis, which will require reading, writing, and oral presentation. ▪ 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**		
3.1	**To show a scientific presentation research, and work independently and integrate with a collaborated group in relevant topics, using IT to analyze, and communicate information.**	▪ Brainstorming. ▪ Exercises ▪ Group Discussion. ▪ Team work. ▪	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	**To appraise effectively the collaboration and inter-professionalism in class discussions or team works, as well as independently.**	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects.	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)	weekly	30 %
2	Midterm Exam	7th week	30 %
3	Final Exam	13^{th} week	40 %
4	Total		100%

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice:

- **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;**
- **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.**
- **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.**
- **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***Stereochemistry of Organic Compounds,*** E. L. Eliel, S. H. Wilen, 1st Ed., Wiley-Interscience, (1994), ISBN-13: 978-0471016700. ***Selectivity in Organic Synthesis,*** R. S. Ward. Wiley-VCH; (1999), ISBN: 978-0-471-98778-9. ***Classics in Stereoselective Synthesis;*** E. M. Carreira, L. Kvaerno 1st Ed., Wiley-VCH, (2009). ISBN-13: 978-3527299669
Essential Reference Materials	***Stereoselective Synthesis in Organic Chemistry***, Atta-ur-Rahman, Z. Shah, , Springer- Verlag, (1993), ISBN 978-1-4613-8327-7
Electronic Materials	• Journal of Organic Chemistry, ACS • Organic Letters, ACS • Tetrahedron • Tetrahedron Letters • Tetrahedron • Tetrahedron Asymmetry • Organic and Biomolecules Chemistry, RSC • European Journal Of Organic Chemistry • Saudi Digital Library
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites.

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**

Item	Resources
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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.
	Course Responsible	**Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد NCAAA T15

Course Specifications (Postgraduate Degree)

Course Title:	**Advanced Electrochemistry and Corrosion**
Course Code:	**CHM 6245**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: 5 (5 Lectures, 0 Lab, 0 Tutorials)	
2. Course type ☐ Required ☒ Elective	
3. Level/year at which this course is offered: Level 4/Year 2	
4. Pre-requisites for this course (if any): Advanced Physical Chemistry – CHM 6141	
5. Co-requisites for this course (if any): None	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

This course presents the fundamentals of the electrode-solution interface, theory of the electrode potential and potentiometry, kinetics of mass and electron transfer, and the electroanalytical techniques: Chronoamperometry and Chronocoulometry, Chronopotentiometry, Linear Sweep Voltammetry, Rotating Disk Electrode. Although these topics are already presented in several books but this information is often distributed in different books or reviews/articles. The purpose of this course is to give unified theory of these topics

2. Course Main Objective

At the end of the course, the students will be able to:

- Recognize advanced electrochemical processes and corrosion.
- Be familiar with Ion Conducting and Electronically Conducting Polymers.
- Memorize Potentiostatic and Galvanostatic Electrochemical methods.
- Develop awareness with Corrosion testing, monitoring and inspection.
- Interpret bimetallic corrosion and Polarisation resistance.

3. Course Learning Outcomes

	CLOs *After completion of the course, The Graduate is able to*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To define the knowledge of fundamental Electrochemistry and describe the Kinetically and Mass Transport Controlled Electrochemical Processes.	K1. *Phy*.; K2. *Phy*.; K4. *Phy*.
1.2	To list the Potentiostatic and Galvanostatic Electrochemical methods, the fundamentals of Corrosion, and the methods used to prevent the corrosion.	K2. *Phy*.; K4. *Phy*.
1.3	To recognize the Electrochemical processes and Corrosion applications in industry.	K2. *Phy*.; K4. *Phy*.
1.4	To state Homogeneous and Heterogeneous Electrocatalysis and its development as well as its importance.	K2. *Phy*.; K3. *Phy*.; K4. *Phy*.
2	**Skills:**	
2.1	To explain the concepts and principles of Electrochemistry and Corrosions.	S1. *Phy*.; S2. *Phy*.; S3. *Phy*.
2.2	To interpret Fundamentals of Corrosion and the methods used to prevent the Corrosion	S2. *Phy*.; S3. *Phy*.
2.3	To summarize the concepts and principles of electrochemistry, Potentiostatic and Galvanostatic Electrochemical Methods data Analysis.	S1. *Phy*.; S2. *Phy*.
2.4	To justify topics of electrochemistry and corrosion, its applications, and impact in KSA industrial sector accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others	S1. *Phy*.; S2. *Phy*.; S3. *Phy*.
3	**Values:**	
3.1	To show a scientific presentation research, working independently or integrating with another research groups in relevant topics, to acquire, analyze, and communicate information.	V1. *Phy*.
3.2	To demonstrate his/her ability to act effectively with the collaboration and inter-professionalism in class discussions or team works, as well as independently.	V1. *Phy*.; V2. *Phy*.

C. Course Content

No	List of Topics	Contact Hours
1	***Introduction to electrochemistry:*** Nernst Equation, Electrode Kinetics, Dynamic Eelectrochemistry, the Butler-Volmer and Tafel Equations. Overpotentials, Kinetically and Mass Transport Controlled Electrochemical Processes, Mass Transport by Migration, Convection and Diffusion, Conductivity, Solid State Electrochemistry, Ion Conducting and Electronically Conducting Polymers, The electrochemical Double Layer.	15
2	***Potentiostatic and Galvanostatic Electrochemical Methods*****:** Chronoamperometry, Coulometry, Cyclic Voltammetry, Chronopotentiometry, AC Impedance Spectroscopy, Spectroelectrochemistry and Hydrodynamic Methods. Surface Confined Electrochemical Processes.	10
3	***The Fundamentals of Corrosionand the methods used to prevent the corrosion.*** theories of corrosion of metals, the most common depolarizers, types of corrosion, consequences of corrosion, factors that control the corrosion rate, Methods of corrosion rate measurement, and corrosion inhibited by different methods **(e.g. Cathodic protection).**	15
4	***Homogeneous and Heterogeneous Electrocatalysis***: Electrochemical Processes Coupled to Chemical Steps. Nanostructured and Surface Modified Electrodes	10
5	***Introduction to Batteries*****:** Fuel Cells and Electrochemical Solar Cells, Electrochemical Processes of Particular Relevance to Energy Conversion.	10
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
1.0	**Knowledge and Understanding**		
1.1	**To define the knowledge of fundamental Electrochemistry and describe the Kinetically and Mass Transport Controlled Electrochemical Processes.**	▪ Five hours/week lectures. ▪ Self-study ▪ Homework.	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion ▪ Participation.
1.2	**To list the Potentiostatic and Galvanostatic Electrochemical methods, the fundamentals of Corrosion, and the methods used to prevent the corrosion.**	▪ Five hours/week lectures. ▪ Think to justify methods used to prevent the Corrosion, using available references (SDL) online ▪ Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.3	**To recognize the Electrochemical processes and Corrosion applications in industry.**	▪ Five hours/week lectures. ▪ Group Discussion on Electrochemical Processes applications using available references (SDL) online.	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation
1.4	**To state Homogeneous and Heterogeneous Electrocatalysis and its development as well as its importance.**	▪ Five hours/week lectures. ▪ Group Discussion 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 Electrochemistry and Corrosions.**	▪ Lectures activity ▪ Self-study. ▪ Deep discussion on principles Electrochemistry and Corrosions.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation ▪ Mini -seminar.
2.2	**To interpret Fundamentals of Corrosion and the methods used to prevent the Corrosion**	▪ Practice some examples of Corrosion the methods used to prevent achieving. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion ▪ Short Quizzes.
2.3	**To summarize the concepts and principles of electrochemistry, Potentiostatic and Galvanostatic Electrochemical Methods data Analysis.**	▪ Lectures ▪ Oral Discussions. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion. ▪ Participation.

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
2.4	**To justify topics of electrochemistry and corrosion, its applications, and impact in KSA industrial sector accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others**	▪ Group Discussion and Assignments ▪ Suggest several applications of electrochemistry and corrosions, 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		
3.1	**To show a scientific presentation research, working independently or integrating with another research groups in relevant topics, Using IT to acquire, analyze, and communicate information.**	▪ Brainstorming. ▪ Exercises ▪ Group Discussion. ▪ Team work.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	**To demonstrate his/her ability to act effectively with the collaboration and inter-professionalism in class discussions or team works, as well as independently.**	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	**Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)**	**weekly**	**30 %**
2	**Midterm Exam**	**7th week**	**30 %**
3	**Final Exam**	**13TH week**	**40 %**
4	**Total**		**100%**

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice: • **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;** • **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.** • **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.** • **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***Instrumental Methods in Electrochemistry***, Pletcher, D.; Greff, R.; Peat, R.; Peter, L. M., Woodhead Publishing, 2002. ISBN-13: 978-1898563808 ***Progress in Corrosion Science and Engineering***, Pyun, Su-Il; Lee, Jong-Won , Springer 2012. ISBN 978-0-387-92263-8 ***Electrochemistry Principles, Methods, and Applications***, Brett, Christopher M. A.; Brett, Ana Maria Oliveira, Oxford University Press; 1 edition, 1993. ISBN-13: 978-0198553885 ***Heterogeneous Electrode Processes and Localized Corrosion***, Yongjun Tan, R. Winston Revie (eds.), 2013. ISBN: 9780470647950.
Essential Reference Materials	**None**
Electronic Materials	• Journal of Solid State Electrochemistry • Electrochemistry Communications • Saudi Digital Library
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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	

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
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Course Specifications
(Postgraduate Degree)

Course Title:	**Advanced kinetics - Heterogeneous Kinetics**
Course Code:	**CHM 6143**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: **5 (5 Lectures, 0 Lab, 0 Tutorials)**	
2. Course type ☐ Required ☒ Elective	
3. Level/year at which this course is offered: **Level 3/Year 1**	
4. Pre-requisites for this course (if any): **Advanced Physical Chemistry – CHM 6141**	
5. Co-requisites for this course (if any): **None**	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

The course is designed to cover the reaction mechanisms, order of reaction, the reaction rate theory and collision theory. This course will extend to cover the basis for the Catalysis and the Transition State Theory of Surface Reactions, Surface Reactivity, The Solid Surface, Work Function, and Kinetics of Reactions on Surfaces.

2. Course Main Objective

At the end of the course, the students will be able to:

- Improve their knowledge of the fundamentals and concepts of advanced kinetics.
- Recognize the mechanisms of heterogeneous catalytic reactions
- Develop their knowledge of the reaction order and reaction rate theory.
- Be familiar with Surface Reactivity.
- Interpret reactions on the surface kinetically.

3. Course Learning Outcomes

CLOs *After completion of the course, The Graduate is able*		Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To list the mechanisms of catalytic reactions, and Kinetics of different types of reactions.	K1. *Phy.*; K2. *Phy.*; K4. *Phy.*
1.2	To state the application of kinetics mechanisms in the Heterogeneous Catalysis field.	K1. *Phy.*; K2. *Phy.*; K3. *Phy.*
1.3	To describe the Surface Reaction Kinetics and the simulation with different models.	K1. *Phy.*; K2. *Phy.*; K3. *Phy.*
1.4	To list Reaction Mechanisms principles.	K2. *Phy.*; K3. *Phy.*; K4. *Phy.*
2	**Skills:**	
2.1	To explain the concepts and principles of Homogeneous Catalysis.	S1. *Phy.*; S2. *Phy.*; S4. *Phy.*
2.2	To analyze problems and explore strategies for Heterogeneous Kinetics, justifying the optimum approaches to appropriate mechanisms.	S1. *Phy.*; S2. *Phy.*; S4. *Phy.*
2.3	To illustrate the mechanisms of Heterogeneous Catalytic Reactions.	S1. *Phy.*; S2. *Phy.*; S4. *Phy.*
2.4	To predict the Reaction Rate Theory applications in a specific circumstances, and accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.	S1. *Phy.*; S2. *Phy.*; K4. *Phy.*
3	**Values:**	
3.1	To illustrate a scientific presentation research, and collaborate with research groups in relevant topics, to acquire, and exchange information.	V1. *Phy.*
3.2	To show his/ her ability to effective collaboration and inter-professionalism in class discussions or team works, as well as independently.	V1. *Phy.*;V2. *Phy.*

C. Course Content

No	List of Topics	Contact Hours
1	***Reaction Mechanisms:*** Langmuir–Hinshelwood or Eley–Rideal Mechanisms, Langmuir–Hinshelwood Kinetics, The Complete Solution, the Steady State Approximation, The Quasi-Equilibrium Approximation, Steps with Similar Rates, Irreversible Step Approximation, The MARI Approximation, Nearly Empty Surface, Reaction Order, Apparent Activation Energy, Entropy, Entropy Production, Auto Catalysis and Oscillating Reactions, Kinetics of Enzyme-catalyzed Reactions.	**10**
2	***Reaction Rate Theory*:** Introduction, The Boltzmann Distribution and the Partition Function, Partition Functions of Atoms and Molecules: The Boltzmann Distribution , Justification for Equating k2 with 1/T, Maxwell–Boltzmann Distribution of Velocities, Total Partition Function of System, Translational Partition Function, Vibrational Partition Function, Rotational (and Nuclear) Partition Function, Electronic and Nuclear Partition Functions, Molecules in Equilibrium, Collision Theory: Rate of Surface Collisions, Reaction Probability, Fundamental Objection Against Collision Theory, Activation of Reacting Molecules by Collisions: The Lindemann Theory, Transition State Theory: Thermodynamic Form of the Rate Transition State Expression, Transition State Theory of Surface Reactions: Adsorption of Atoms, Indirect Adsorption, Direct Adsorption, Adsorption of Molecules, Precursor-mediated or Indirect Adsorption, Direct Adsorption, Reaction Between Adsorbates, Desorption of Molecules**.**	**15**
3	***Surface Reactivity:*** Introduction, Physisorption: The Van der Waals Interaction, Including the Repulsive Part, Chemical Bonding: Bonding in Molecules, Diatomic Molecule, Homonuclear Diatomic Molecules, Heteronuclear System, The Solid Surface, Work Function, Free Electron Gas and the Jellium Model, Tight Binding Model, Simple Model of a Transition Metal, Chemisorption: Newns–Anderson Model, Atomic Adsorption on a Transition or d Metal, Adsorption of a Molecule on a Transition Metal, Electrostatic Effects in Atomic Adsorbates on Jellium, Important Trends in Surface Reactivity, Trend in Atomic Chemisorption Energies, Trends in Molecular Chemisorption, Trends in Dissociative Adsorption, Transition States and the Effect of Coverage:Ethylene Hydrogenation, Sabatier's Principle, Opportunities for Tuning Surface Reactivity, Universality in Heterogeneous Catalysis	**20**
4	***Kinetics of Reactions on Surfaces:*** Elementary Surface Reactions: Adsorption and Sticking , Determination of Sticking Coefficients, Desorption, Quantitative Interpretation of TPD Data, Compensation Effect in Temperature Programmed Desorption, Lateral Interactions in Surface Reactions, Dissociation Reactions on Surfaces, Intermediates in Surface Reactions, Association Reactions, Kinetic Parameters from Fitting Langmuir–Hinshelwood Models, Micro-kinetic Modeling: Reaction Scheme and Rate Expressions, Activation Energy and Reaction Orders, Ammonia Synthesis Catalyst under Working Conditions	**15**
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	**To list the mechanisms of catalytic reactions, and Kinetics of different types of reactions.**	▪ Five hours/week lectures. ▪ Self-study ▪ Homework.	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion ▪ Participation.
1.2	**To state the application of kinetics mechanisms in the Heterogeneous Catalysis field.**	▪ Five hours/week lectures. ▪ *Think* to *justify* the application of kinetics mechanisms in the heterogeneous catalysis, using available references (SDL) online. ▪ Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.3	**To describe the Surface Reaction Kinetics and the simulation with different models.**	▪ Five hours/week lectures. ▪ *Group Discussion* using available references (SDL) online.	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.4	**To list Reaction Mechanisms principles.**	▪ Five hours/week lectures. ▪ *Group Discussion* on Reaction Mechanisms principles 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 Catalysis.**	▪ Lectures activity ▪ Self-study. ▪ *Group Discussion* deeply on the principles of homogeneous catalysis.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation ▪ Mini -seminar.
2.2	**To analyze problems and explore strategies for Heterogeneous Kinetics, justifying the optimum approaches to appropriate mechanisms.**	▪ *Practice* some examples of heterogeneous catalysis to optimize appropriate mechanisms achieving. ▪ Brainstorming. ▪ Self-study.	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion ▪ Short Quizzes.
2.3	**To illustrate the mechanisms of Heterogeneous Catalytic Reactions.**	▪ Lectures ▪ Oral Discussions. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion. ▪ Participation.
2.4	**To predict the Reaction Rate Theory applications in a specific circumstances,**	▪ *Group Discussion* and Assignments.	▪ Oral Discussion. ▪ Quizzes, and Exams.

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
	and accompanying writing of mini-Reports, operating electronic mail, and Network in communicating with others.	▪ *Suggest* several examples for evaluations Reaction Rate Theory applications, for reading, writing, and oral presentation in groups. ▪ Encourage students to use electronic mail to submit Home Exams and Assignments.	▪ Giving marks for Oral Discussion in Lectures. ▪ Marks given for Assignments.
3.0	**Values**		
3.1	**To illustrate a scientific presentation research, and collaborate with research groups in relevant topics, to acquire, and exchange information.**	▪ Brainstorming. ▪ Exercises ▪ Group Discussion. ▪ Team work. ▪	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	**To show his/ her ability to effective collaboration and inter-professionalism in class discussions or team works, as well as independently.**	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects.	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	**Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)**	**weekly**	**30 %**
2	**Midterm Exam**	**7th week**	**30 %**
3	**Final Exam**	**13th week**	**40 %**
4	**Total**		**100%**

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice: • **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;** • **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.** • **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.** • **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***Concepts of Modern Catalysis and Kinetics,*** I. Chorkendorff, J. W. Niemantsverdriet, 2nd, Revised and Enlarged Edition, 2007, Wiley-VCH. ISBN: 978-3-527-31672-4. ***Kinetics of Heterogeneous catalytic Reactions***, M. Boudart, G. Djega-Mariadassou, 2016, Princeton University Press, 2016, ISBN: 9780691640488. ***Adsorption onto Heterogeneous Porous Materials: Equilibria and Kinetics, Mexmat,*** Aarden F.B.,2001.
Essential Reference Materials	**None**
Electronic Materials	• Saudi Digital Library
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites.

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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.
	Course Responsible	**Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Advanced Quantum Chemistry**
Course Code:	**CHM 6247**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: 5 (5 Lectures, 0 Lab, 0 Tutorials)	
2. Course type ☐ Required ☒ Elective	
3. Level/year at which this course is offered: Level 5/Year 2	
4. Pre-requisites for this course (if any): Advanced Physical Chemistry – CHM 6141	
5. Co-requisites for this course (if any): None	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

This course deals with History of QM and postulates, Particle in the box, particle in three dimensional box, Basic operator algebra, Harmonic oscillator and rigid rotor, Vibrational and rotational spectroscopy. The hydrogen atom wave function (radial and angular parts), atomic orbitals. Many-electron atoms, Hartree-Fock, quantum states, term symbols, Atomic spectroscopy, The chemical bond, molecular orbital theory, Electronic spectroscopy. Approximation methods: perturbation Theory, variation theory, Pauli principle, Slater determinants. Computational chemistry cont., nuclear spins.

2. Course Main Objective

At the end of the course, the students will be able to:

- Improve their knowledge of the fundamentals and concepts of advanced quantum chemistry.
- Recognize the applications of Schrodinger Eq. For one electron atom and many electron atoms.
- Develop their knowledge of the Quantum mechanics and atomic molecular and electronic spectroscopy.
- Be familiar with Approximation methods: perturbation Theory.
- Identify Computational chemistry.

3. Course Learning Outcomes

CLOs	*After completion of the course, The Graduate is able to*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recall the basic operator algebra, Harmonic oscillator and rigid rotor, Vibrational and rotational spectroscopy. Recognize the principles of the particle in the box, particle in three- dimensional box.	K1. *Phy.*; K4. *Phy.*
1.2	To describe the Structure and spectra of hydrogen atomic orbitals and Many-electron atoms, Hartree-Fock, quantum states, Atomic spectroscopy, Electronic spectroscopy.	K1. *Phy.*; K4. *Phy.*
1.3	To define the approximation methods.	K1. *Phy.*; K4. *Phy.*
1.4	To recognize the application of Quantum mechanics and atomic molecular, and electronic spectroscopy.	K1. *Phy.*; K3.*Phy.*; K4. *Phy.*
2	**Skills:**	
2.1	To explain the concepts and principles of quantum chemistry.	S1. *Phy.*; S2.*Phy.*
2.2	To analyze problems and explore strategies to calculate the energies of atomic orbital for hydrogen and hydrogen-like atoms and many -electron atoms.	S1. *Phy.*; S3.*Phy.*
2.3	To summarize Basic principles of Quantum mechanics and its Applications.	S1. *Phy.*
2.4	To design computational chemistry calculations for certain problems, and its applications in Quantum mechanics and atomic molecular, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.	S1. *Phy.*; K4. *Phy.*
3	**Values:**	
3.1	To judge a scientific presentation, and work independently or with other groups on relevant topics, using IT to analyze, and communicate information	V1.*Phy.*
3.2	To appraise effectively the collaboration and inter-professionalism in class discussions or team works, as well as independently.	V1. *Phy.*; V1. *Phy.*

C. Course Content

No	List of Topics	Contact Hours
1	***Basic principles of Quantum mechanics (QM): Schrödinger equationand the postulates of QM. Applications of Quantum mechanics***: Study the applications of QM on some simple systems and include the translational, vibration and rotation motions: the translational motions: motion of Particle in the box, motion of particle in three-dimensional box, Vibrational motion: include harmonic oscillator, rotational motion: include rigid rotor. Vibrational and rotational spectroscopy.	**20**
2	***The hydrogen atom:*** Wave function of the hydrogen atom (radial and angular parts), atomic orbitals.	**7**
3	***Many-electron atoms:*** Hartree-Fock method and Slater determinants, quantum states, term symbols, Atomic spectroscopy, the chemical bond, molecular orbital theory, Hückel method calculations to determine electron energies of molecular orbitals, Electronic spectroscopy.	**8**
4	***Approximation methods in QM***: Perturbation Theory, variation theory.	**10**
5	***Pauli principle and nuclear spins.***	**5**
6	***Computational chemistry:*** Methods of theoretical chemistry, incorporated into efficient computer programs, to calculate the structures and properties of molecules and solids using ab initio and semi-empirical approaches.	**10**
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
1.0	**Knowledge and Understanding**		
1.1	To recall the basic operator algebra, Harmonic oscillator and rigid rotor, Vibrational and rotational spectroscopy. Recognize the principles of the particle in the box, particle in three- dimensional box.	▪ Five hours/week lectures. ▪ Self-study ▪ Homework.	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion ▪ Participation.
1.2	To describe the Structure and spectra of hydrogen atomic orbitals and Many-electron atoms, Hartree-Fock, quantum states, Atomic spectroscopy, Electronic spectroscopy.	▪ Five hours/week lectures. ▪ Think to justify the Characterization Techniques applications in Atomic spectroscopy, using available references (SDL) online ▪ Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.3	To define the approximation methods.	▪ Five hours/week lectures. ▪ Group Discussion using available references (SDL) online.	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.4	To recognize the application of Quantum mechanics and atomic molecular, and electronic spectroscopy.	▪ Five hours/week lectures ▪ Group Discussion on application of Quantum mechanics and atomic molecular, 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 quantum chemistry.	▪ Lectures activity ▪ Self-study. ▪ Deep discussion on concepts and principles of quantum chemistry.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation ▪ Mini –seminar.
2.2	To analyze problems and explore strategies to calculate the energies of atomic orbital for hydrogen and hydrogen-like atoms and many - electron atoms.	▪ Practice some examples to calculate the energies of atomic orbital, achieving. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion ▪ Short Quizzes.
2.3	To summarize Basic principles of Quantum mechanics and its Applications.	▪ Lectures ▪ Oral Discussions. ▪ Brainstorming.	▪ Questions in Lectures. ▪ Short Quizzes and

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
		▪ Self-study	Exams. ▪ Oral Discussion. ▪ Participation.
2.4	**To design computational chemistry calculations for certain problems, and its applications in Quantum mechanics and atomic molecular, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.**	▪ Group Discussion and Assignments. ▪ Suggest several examples of Computational chemistry, and its applications in Quantum mechanics, 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**		
3.1	**To judge a scientific presentation, and work independently or with other groups on relevant topics, using IT to analyze, and communicate information**	▪ Brainstorming. ▪ Exercises ▪ Group Discussion. ▪ Team work.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	**To appraise effectively the collaboration and inter-professionalism in class discussions or team works, as well as independently.**	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	**Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)**	**weekly**	**30 %**
2	**Midterm Exam**	**7th week**	**30 %**
3	**Final Exam**	**13^{th} week**	**40 %**
4	**Total**		**100%**

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice: • **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;** • **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.** • **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.** • **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***Quantum Chemistry and Spectroscopy.*** Engel, Th., Pearson, Boston, 3rd edition, 2013. ISBN-13: 978-0321766199 ***Molecular Quantum Chemistry***. Atkins, P. W.; Friedman, R. S. Oxford University Press, 5th ed. 2010. ISBN: 9780199541423. ***Quantum Chemistry***. Levine, I. N. , Pearson, Boston, 7th edition, 2013. ISBN-13: 978-0321803450
Essential Reference Materials	• ***Quantum Chemistry***, I. N. Levine, 7th Ed., Pearson, Boston, (2014), ISBN-13: 978-0321803450
Electronic Materials	• Saudi Digital Library
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites.

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	**Direct:** Questionnaire.
	Course Responsible	**Direct:** Course e-Portfolio.

Evaluation Areas/Issues	Evaluators	Evaluation Methods
		Indirect: Second examiner checklist-Course report.
	Peer Reviewer	**Direct:** Questionnaire. **Indirect:** External assessor report.
Effectiveness of assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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.
	Course Responsible	**Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

T15

Course Specifications (Postgraduate Degree)

Course Title:	Catalysis and its Industrial Applications
Course Code:	CHM 6244
Program:	Master of Science in Chemistry
Department:	Chemistry
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

Table of Contents

A. Course Identification

1. Credit hours: 5 (5 Lectures, 0 Lab, 0 Tutorials)	
2. Course type ☐ Required ☒ Elective	
3. Level/year at which this course is offered: Level 4/Year 2	
4. Pre-requisites for this course (if any): Advanced Physical Chemistry – CHM 6141	
5. Co-requisites for this course (if any): None	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course 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.

2. Course Main Objective

At the end of the course, the students will be able to:

- 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.

3. Course Learning Outcomes

	CLOs *After completion of the course, The Graduate is able*	Aligned PLOs
1	**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*.
1.2	To state catalyst development, planning and, testing.	K1. *Phy*.; K3. *Phy*.
1.3	To describe the bio-catalysis and Electro-catalysis.	K1. *Phy*.; K3. *Phy*.
1.4	To recognize on the catalysis Reactors and their development.	K3. *Phy*.; K4. *Phy*.
2	**Skills:**	
2.1	To explain the concepts and principles of Homogeneous and Heterogeneous Catalysis in industry	S1. *Phy*.
2.2	To compare Homogeneously and Heterogeneously Catalyzed Industrial Processes and Bio-catalysis.	S1. *Phy*.; S2. *Phy*.; S3. *Phy*.
2.3	To estimate the individual steps in the Heterogeneous, and Homogenous Catalysis process and its mechanisms in catalytic reactions.	S1. *Phy*.; S2. *Phy*.; S3. *Phy*.
2.4	To justify 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*.
3	**Values:**	
3.1	To show a scientific presentation research, and integrate with a collaborated groups of relevant topics, Using IT to acquire, serve the industrial and social community, and exchange information.	V1. *Phy*.
3.2	To appraise effectively the collaboration and inter-professionalism in class discussions or team works, as well as independently..	V1. *Phy*.; V2. *Phy*.

C. Course Content

No	List of Topics	Contact Hours
1	***Introduction:*** homogenous and hetergenous catalysis	5
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.	10
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.	6
4	***Biocatalysis:*** introduction, kinetics of enzyme-catalyzed reactions, biocatalytic industrial processes, acrylamide preparation from acrylonitrile	4
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	6
6	***Forms of catalysts and production of heterogeneous catalysts:*** Production of catalysts	4
7	***Selective catalyst: zeolite***: composition and structure of zeolites, production of zeolites, catalytic properties of zeolites**.**	5
8	***Heterogeneous catalytic processes in industry***: an overview, examples of industrial processes, manufacture of circulating and rare chemicals	4
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.	5
12	***The economic importance of catalysts.***	5
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	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**	▪ Five hours/week lectures. ▪ Self-study ▪ Homework.	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion ▪ Participation.
1.2	**To state catalyst development, planning and, testing.**	▪ Five hours/week lectures. ▪ *Think* to justify Catalyst development, using available references (SDL) online. ▪ Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.3	**To describe the bio-catalysis and Electro-catalysis.**	▪ 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.**	▪ 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**	▪ 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.**	▪ *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 estimate the individual steps in the Heterogeneous, and Homogenous Catalysis process and its mechanisms in catalytic reactions.**	▪ Lectures ▪ Oral Discussions. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion. ▪ Participation.

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
2.4	To justify 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..	▪ 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		
3.1	To show a scientific presentation research, and integrate with a collaborated groups of relevant topics, Using IT to acquire, serve the industrial and social community, and exchange information.	▪ Brainstorming. ▪ Exercises ▪ Group Discussion. ▪ Team work.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	To appraise effectively the collaboration and inter-professionalism in class discussions or team works, as well as independently.	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)	weekly	30 %
2	Midterm Exam	7 th week	30 %
3	Final Exam	13th week	40 %
4	Total		100%

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice: • **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;** • **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.** • **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.** • **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***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
Essential Reference Materials	**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.

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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.
	Course Responsible	**Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Materials, Surfaces and Interfaces**
Course Code:	**CHM 6246**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: **5 (5 Lectures, 0 Lab, 0 Tutorials)**	
2. Course type ☐ Required ☒ Elective	
3. Level/year at which this course is offered: **Level 4/Year 2**	
4. Pre-requisites for this course (if any): **Advanced Physical Chemistry – CHM 6141**	
5. Co-requisites for this course (if any): **None**	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

This course presents the basis to identify the surface properties that influence interfacial reactions in metal and nonmetal systems. It includes the reactivity at the interfaces of different materials with some applications as biosensor and catalysis. The material section will include nanomaterials with the basic principles of surface science.

2. Course Main Objective

At the end of the course, the students will be able to:

- Improve their knowledge on surfaces and surfaces functions.
- Recognize the reactivity of Oxides in the solid-liquid interface.
- Develop their knowledge on the application of surface interface with catalysis and coordination chemistry as well Prebiotic Chemistry.
- Outline surface functionalization and its applications.
- Be familiar with Characterization Techniques of interface, surface and nanomaterials.

3. Course Learning Outcomes

	CLOs *After completion of the course, The Graduate is able to*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To describe the materials surface properties, Concept of Surface Sites, and the Reactivity of the interface.	K1. *Phy.*; K2. *Phy.*; K3. *Phy.*
1.2	To list the Characterization Techniques and recognize the Surface functionalization.	K2. *Phy.*; K3. *Phy.*
1.3	To state the complements of Characterization Techniques.	K2. *Phy.*; K3. *Phy.*
1.4	To recognize the application of surface interface with catalysis and coordination chemistry as well Prebiotic Chemistry.	K3. *Phy.*
2	**Skills:**	
2.1	To explain the concepts the materials Sciences and surface functionalization with its applications.	S1. *Phy.*; S2. *Phy*;
2.2	To analyze Characterization Techniques of interface, surface, and nanomaterials.	S2. *Phy*; S3. *Phy.*
2.3	To summarize Surface functionalization and its applications and roles.	S1. *Phy.*; S2. *Phy.*
2.4	To compare surfaces and surfaces functions, its applications in nanomaterials, and impact in KSA industrial sector accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.	S3. *Phy*; S4. *Phy.*
3	**Values:**	
3.1	To demonstrate scientific research, independently and collaborate with groups in relevant topics.	V1.*Phy.*
3.2	To use all information gained effectively, with research team in class discussions or team works, as well as independently.	V1.*Phy.*; V2. *Phy.*

C. Course Content

No	List of Topics	Contact Hours
1	***Introduction:*** General information on surfaces of powdered and bulk materials, nanosized materials, Industrial Issues, Concept of Surface Sites	5
2	***Reactivity to the interface:*** Behavior of Oxides in the Solid-liquid Interface, Surface Charge and Reactivity with Respect to Electrostatic Adsorption. Example applications 1: Development of Heterogeneous Catalysts: Coordination Chemistry Interfacial Adsorption and Grafting, Adsorption Isotherms. Application Example 2: Prebiotic Chemistry, Amino Acids Adsorption.	10
3	***Characterization Techniques:*** Physisorption Nitrogen, Electron Microscopy, X-ray Photoelectron Spectroscopy.	10
4	***Surface functionalization:*** Concept of Self-Assembled Monolayers, Grafting, Liaison Officers, Vibration Spectroscopy on Flat Surfaces. Application Example 3: Biosensor, a Physical Chemist Approach Biomolecules, Molecular Recognition. Application Example 4: Surface Anti-biofilm, how to Inhibit Adsorption?	10
5	***Characterization Techniques:*** IR Spectroscopy Surface, Near Field Microscopy.	10
6	***Nanomaterials:*** From Micro to Nano, the Effects of the Nanoscale. Study of Gold Nanoparticles, Biological and Catalytic Applications.	8
7	***Characterization techniques:*** Raman Spectroscopy, and Raman Exalted Surface.	7
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	**To describe the materials surface properties, Concept of Surface Sites, and the Reactivity of the interface.**	▪ Five hours/week lectures. ▪ Self-study ▪ Homework	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion ▪ Participation.
1.2	**To list the Characterization Techniques and recognize the Surface functionalization.**	▪ Five hours/week lectures. ▪ *Think* to justify the Characterization Techniques and the Surface functionalization, using available references (DSL) online ▪ Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.3	**To state the complements of Characterization Techniques.**	▪ Five hours/week lectures. ▪ Group Discussion with mini-reports the complements of Characterization Techniques applications, using available references (DSL) online.	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.4	**To recognize the application of surface interface with catalysis and coordination chemistry as well Prebiotic Chemistry.**	▪ Five hours/week lectures. ▪ Group Discussion using available references (SDL) online.	▪ Assignments ▪ Open Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
2.0	**Skills**		
2.1	**To explain the concepts the materials Sciences and surface functionalization with its applications.**	▪ Lectures activity ▪ Self-study. ▪ Deep discussion on Materials Sciences and surface functionalization.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation ▪ Mini -seminar.
2.2	**To analyze Characterization Techniques of interface, surface, and nanomaterials.**	▪ Practice some examples to analyze Characterization Techniques of interface achieving ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion ▪ Short Quizzes.
2.3	**To summarize Surface functionalization and its applications and roles.**	▪ Lectures ▪ Oral Discussions. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion. ▪ Participation.

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
2.4	**To compare surfaces and surfaces functions, its applications in nanomaterials, and impact in KSA industrial sector accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.**	▪ Group Discussion and Assignments. ▪ Suggest several examples of nanomaterials applications and impact in the KSA industry, for reading, writing, and oral presentation in group. ▪ 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**		
3.1	**To demonstrate scientific research, independently and collaborate with groups in relevant topics.**	▪ Brainstorming. ▪ Exercises ▪ Group Discussion. ▪ Team work.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	**To use all information gained effectively, with research team in class discussions or team works, as well as independently.**	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects	▪ Participation ▪ Homework's ▪ Mini-project(s).

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2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	**Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)**	**weekly**	**30 %**
2	**Midterm Exam**	**7 th week**	**30 %**
3	**Final Exam**	**13th week**	**40 %**
4	**Total**		**100%**

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice: • **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;** • **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.** • **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.** • **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***Chemical Properties of Material Surfaces***, Kosmulski, M. CRC Press, 2011. ISBN 9780824705602 - CAT# DK1803 ***Encyclopedia of Materials Characterization: Surfaces, Interfaces, Thin Films*** (Materials Characterization Series), Evans, Ch.; Brundle, R. Butterworth-Heinemann, W 1992.ISBN: 978-0-08-052360-6
Essential Reference Materials	• ***Handbook of Surfaces and Interfaces of Materials***, Five-Volume Set, H. Nalwa, 2001, Academic Press, ISBN: 9780125139106 • Saudi Digital Library
Electronic Materials	• Saudi Digital Library**.**
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites.

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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.
	Course Responsible	**Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Nanomaterials and Hybrid Materials**
Course Code:	**CHM 6142**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: 5 (5 Lectures, 0 Lab, 0 Tutorials)	
2. Course type ☐ Required ☒ Elective	
3. Level/year at which this course is offered: Level 3/Year 1	
4. Pre-requisites for this course (if any): Advanced Physical Chemistry – CHM 6141	
5. Co-requisites for this course (if any): None	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

The course will provide a theoretical description of the basic principles and fundamental properties of nanomaterials, and the physical and chemical properties of nanoscale structures. It will cover methods for designing and fabricating. The Second part is composed by an introduction to the basic chemical principles and characterization of hybrid materials; Interface-determined Materials, Hybrid Materials by the Sol–Gel Process, Organic Building Blocks, Structural Engineering, an overview of specific types of hybrid materials and some applications will be discussed.

2. Course Main Objective

At the end of the course, the students will be able to:

- Improve their knowledge of the advanced information of nanostructured materials synthesis and fabrication.
- Recognize the reactivity of surface oxides.
- Develop their knowledge of the hybrid materials and nanocomposites.
- Be familiar with synthesis and characteristics hybrid materials with an overview of their potential applications.

3. Course Learning Outcomes

	CLOs *After completion of the course, The Graduate is able*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recall knowledge of nanotechnology, nanomaterials categories and their synthetic methods.	K1. *Phy.*; K4. *Phy.*
1.2	To state different characterization methods of Nanomaterials and their applications.	K2. *Phy.*; K3. *Phy.*; K4. *Phy.*
1.3	To describe the Hybrid Materials characterization and applications.	K3. *Phy.*; K4. *Phy.*
1.4	To recognize the applications of Nanomaterials and Nanoscience.	K4. *Phy.*
2	**Skills:**	
2.1	To explain the concepts and principles of material, nanomaterials, and hybrid materials.	S1. *Phy.*; S2. *Phy.*; S4. *Phy.*
2.2	To interpret nanomaterials and hybrid materials characterization and their correlation with synthetic methods.	S2. *Phy.*; S3. *Phy.*
2.3	To illustrate the Nanostructured materials synthesis and fabrication.	S1. *Phy.*; S2. *Phy.*
2.4	To differentiate Nanostructures Materials Synthesis and Fabrication, its applications, and impact in KSA industrial sector accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.	S2. *Phy.*; S3. *Phy.*; S4. *Phy.*
3	**Values:**	
3.1	To demonstrate scientific research, independently and collaborate with groups in relevant topics.	V1. *Phy.*
3.2	To use all information gained effectively, with research team in class discussions or team works, as well as independently.	V1. *Phy.*; V2. *Phy.*

C. Course Content

No	List of Topics	Contact Hours
Nanomaterials		
1	***Nanomaterials:*** Synthesis strategies and formatting: single-crystal micro- or nanoscale powder**. Gel, colloid:** which method of synthesis and any formatting for any property, Inorganic polymerisation. The passage of the metal ion in solution at a solid oxide phase. **Condensation mechanisms of cations**: in solution are studied in detail to learn how to control the size, structure and morphology of nanoscale systems.	**15**
2	***The reactivity of surface oxides:*** presented in conjunction with the adsorption and grafting phenomena to understand the functionalization of surfaces and the formation of organic-inorganic hybrid materials.	**5**
3	***Nanomaterials and Nanosciences:*** the emergence of Nanosciences in future technologies, "Top-down": the future of computers; Moore's Law; mesoscopic field: example of the Aharonov-Bohm effect; **Coulomb blockade of single electron transistor** and; spintronics, "Bottom-up" principle of the scanning tunneling microscope; Atomic and molecular manipulation; **Chemistry atom by atom;** manipulating electronic waves: the Kondo effect, Features of molecular nanomachines, role of fluctuations in the operation. Exotic forms of carbon: fullerenes and nanotubes.	**15**
Hybrid Materials:		
4	Introduction to Hybrid Materials, Natural Origins, The Development of Hybrid Materials, **Definition:** Hybrid Materials and Nanocomposites, Advantages of Combining Inorganic and Organic Species in One Material.	**5**
5	***Interface-determined Materials*****:** The Role of the Interaction Mechanisms, Synthetic Strategies towards Hybrid Materials, **In situ Formation of Inorganic Materials**, Sol–Gel Process, Nonhydrolytic Sol–Gel Process, Sol–Gel Reactions of Non-Silicates,	**8**
6	***Hybrid Materials by the Sol–Gel Process:*** Hybrid Materials Derived by Combining the Sol–Gel Approach and Organic Polymers, Formation of Organic Polymers in Presence of Preformed Inorganic Materials.	**5**
7	***Hybrid Materials by Simultaneous Formation*****:** of Both Components, Building Block Approach, Inorganic Building Blocks, **Organic Building Blocks, Structural Engineering**, Properties and Applications, Characterization of Materials	**7**
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	To recall knowledge of nanotechnology, nanomaterials categories and their synthetic methods.	▪ Five hours/week lectures. ▪ Self-study ▪ Homework.	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion ▪ Participation.
1.2	To state different characterization methods of Nanomaterials and their applications.	▪ Five hours/week lectures. ▪ Think to justify the different methods of characterization for nanomaterials, using available references (SDL) online. ▪ Open discussion	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.3	To describe the Hybrid Materials characterization and applications.	▪ Five hours/week lectures. ▪ Group Discussion using available references (SDL) online.	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.4	To recognize the applications of Nanomaterials and Nanoscience.	▪ Five hours/week lectures. ▪ Group Discussion with mini-reports 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 material, nanomaterials, and hybrid materials.	▪ Lectures activity ▪ Self-study. ▪ Think, and discuss nanomaterials and hybrid materials concepts.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation. ▪ Mini -seminar.
2.2	To interpret nanomaterials and hybrid materials characterization and their correlation with synthetic methods.	▪ Suggest of examples hybrid materials characterization, achieving. ▪ Brainstorming. ▪ Self-study.	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion ▪ Short Quizzes.
2.3	To illustrate the Nanostructured materials synthesis and fabrication.	▪ Lectures ▪ Oral Discussions. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion. ▪ Participation.

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
2.4	**To differentiate Nanostructures Materials Synthesis and Fabrication, its applications, and impact in KSA industrial sector accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.**	▪ Group Discussion and Assignments ▪ Suggest examples of nanostructured materials synthesis and fabrication, for evaluations, which will require 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		
3.1	**To demonstrate scientific research, independently and collaborate with groups in relevant topics.**	▪ Brainstorming. ▪ Exercises ▪ Group Discussion. ▪ Team work.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	**To use all information gained effectively, with research team in class discussions or team works, as well as independently.**	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects.	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	**Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)**	**weekly**	**30 %**
2	**Midterm Exam**	**7 th week**	**30 %**
3	**Final Exam**	**13^{th} week**	**40 %**
4	**Total**		**100%**

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice: • **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;** • **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.** • **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.** • **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***Advanced Nanomaterials,*** Geckeler K.E.; Nishide H. (eds.) Wiley-VCH, 2010. ISBN:978-3-527-32414-9 ***Nanomaterials for Environmental Protection*** , **Kharisov, B. I.; Kharissova, O. V., Rasika Dias**, H.V.;Wiley-VCH, 2014. ISBN: 978-1-118-49697-8 ***Bio-inorganic Hybrid Nanomaterials: Strategies, Synthesis Characterization and Applications***, **Euiz-Hitzky E.; Ariga K., Lvov Yu. (eds**.), Wiley-VCH, 2008. ISBN: 978-3-527-31718-9 ***Hybrid Materials: Synthesis, Characterization, and Applications***, **Kickelbick, G.;** Wiley-VCH, 2008. ISBN: 978-3-527-31299-3
Essential Reference Materials	**None**
Electronic Materials	• Nano Today • Nano Energy • Nano and Microstructural Design of Advanced Materials • Composites Science and Technology • Saudi Digital Library. Blackboard • Multimedia associated with the text book and the relevant websites.
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites.

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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.
	Course Responsible	**Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Physical Applications of Green Chemistry**
Course Code:	**CHM 6248**
Program:	**Master of Science in Chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: **5 (5 Lectures, 0 Lab, 0 Tutorials)**	
2. Course type ☐ Required ☒ Elective	
3. Level/year at which this course is offered: **Level 5/Year 2**	
4. Pre-requisites for this course (if any): **Advanced Physical Chemistry – CHM 6141**	
5. Co-requisites for this course (if any): **None**	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		**60**

B. Course Objectives and Learning Outcomes

1. Course Description

This course will provide a wealth of information to chemistry students involved in chemical synthesis and processing at the research, applied, and management levels and will also act as a catalyst in stimulating many more chemists to become involved in the design and use of chemical syntheses and processes in an environmentally responsible manner.

2. Course Main Objective

At the end of the course, the students will be able to:

- Know the environmental status and evolution and the Pollution and its prevention measures
- Understand the emerging greener technologies and alternative energy sources
- Be an expertise global warming and its effects
- Learn about the control and remedial measures of the greenhouse effect
- Know about designing greener processes and industrial case studies.

3. Course Learning Outcomes

	CLOs *After completion of the course, The Graduate is able to*	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To recall knowledge of the principles and concepts of Green Chemistry	K1. *Phy.*; K3. *Phy.*
1.2	To state the important application of Catalysis in Green Chemistry and Organic Solvents environmentally benign solutions and Renewable Resources.	K1. *Phy.*; K2. *Phy.*; K3. *Phy*
1.3	To outline the designing greener processes and industrial case studies	K1. *Phy.*; K3. *Phy*
1.4	To list the renewable Resources, and Emerging Greener Technologies, and Alternative Energy Sources.	K1. *Phy.*; K2. *Phy.*; K4. *Phy*
2	**Skills:**	
2.1	To explain the concepts of green chemistry and its applications.	S1. *Phy.*; S4. *Phy.*
2.2	To analyze emerging greener technologies and alternative energy sources needs and solutions.	S1. *Phy.*; S2. *Phy.*; S3. *Phy.*
2.3	To summarize Waste, Production, Problems and Prevention and treatment methods to act as sustainable material in green way.	S1. *Phy.*; S2. *Phy.*
2.4	To predict Green Chemistry as a tool for more health environment improvement, and its applications, accompanying writing of mini-Reports, operating electronic mail, and Network in communicating with others.	S1. *Phy.*; S4. *Phy.*
3	**Values:**	
3.1	To demonstrate scientific research, independently and collaborate with groups in relevant topics.	V1. *Phy.*
3.2	To use all information gained effectively, with research team in class discussions or team works, as well as independently.	V1. *Phy.*; V2. *Phy.*

C. Course Content

No	List of Topics	Contact Hours
1	***Principles and Concepts of Green Chemistry*:** Introduction on Green Chemistry. Reducing Toxicity: Measuring Toxicity	5
2	***Waste: Production, Problems and Prevention***: Introduction, Some Problems Caused by Waste, Sources of Waste from the Chemical Industry, The Cost of Waste, Waste Minimization Techniques: Physical Treatment, Chemical Treatment, Biotreatment Plants.	6
3	***Catalysis and Green Chemistry:*** Introduction to Catalysis, Heterogeneous Catalysts: Comparison of Catalyst Types, Basics of Heterogeneous Catalysis, Zeolites and the Bulk Chemical Industry, Heterogeneous Catalysis in the Fine Chemical and Pharmaceutical Industries, Catalytic Converters, Homogeneous Catalysis, Biocatalysis, Photocatalysis.	10
4	***Organic Solvents:*** Environmentally Benign Solutions: Organic Solvents and Volatile Organic Compounds, Solvent-free Systems, Water as a Reaction Solvent: Water-based Coatings, Ionic Liquids: Ionic Liquids as Catalysts, Ionic Liquids as Solvents.	10
5	***Renewable Resources:*** Biomass as a Renewable Resource, Energy: Fossil Fuels, Energy from Biomass, Solar Power, Other Forms of Renewable Energy, Fuel Cells, Chemicals from Renewable Feedstocks: Chemicals from Fatty Acids, Polymers from Renewable Resources, Some Other Chemicals fiom Natural Resources.	5
6	***Emerging Greener Technologies and Alternative Energy Sources:*** Design for Energy Efficiency, Photochemical Reactions Processes: Advantages of and Challenges Faced by Photochemical, Examples of Photochemical Reactions, Chemistry Using Microwaves: Microwave Heating, Microwave-assisted Reactions, Sonochemistry and Green Chemistry, Electrochemical Synthesis: Examples of Electrochemical Synthesis.	10
7	***Designing Greener Processes:*** Conventional Reactors: Batch Reactors, Continuous Reactors, Inherently Safer Design: Minimization, Simplification, Substitution, Moderation, Limitation, Process Intensification: Some PI Equipment.	7
8	***Industrial Case Studies***: A Brighter Shade of Green, Greening of Acetic Acid Manufacture, EPDM Rubbers, Vitamin C, Leather Manufacture: Tanning, Fat liquoring, dyeing to be Green: Some Manufacturing and Products Improvements, Dye Application, Polyethene: Radical Process, Ziegler-Natta Catalysis, Metallocene Catalysis, Eco-friendly Pesticides: Insecticides.	7
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	**To recall knowledge of the principles and concepts of Green Chemistry**	▪ Five hours/week lectures. ▪ Self-study ▪ Homework	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion ▪ Participation.
1.2	**To state the important application of Catalysis in Green Chemistry and Organic Solvents environmentally benign solutions and Renewable Resources.**	▪ Five hours/week lectures. ▪ *Think* to justify application of Catalysis in Green Chemistry and Renewable Resources, using available references (SDL) online. ▪ Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.3	**To outline the designing greener processes and industrial case studies**	▪ Five hours/week lectures. ▪ Group Discussion using available references (SDL) online.	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.4	**To list the renewable Resources, and Emerging Greener Technologies, and Alternative Energy Sources.**	▪ Five hours/week lectures. ▪ Group Discussion on Renewable Resources, and Emerging Greener Technologies, using available references (SDL) online.	▪ Assignments ▪ Open Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
2.0	**Skills**		
2.1	**To explain the concepts of green chemistry and its applications.**	▪ Lectures activity ▪ Self-study. ▪ Deep discussion on concepts and principles of green chemistry and its applications.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation ▪ Mini -seminar.
2.2	**To analyze emerging greener technologies and alternative energy sources needs and solutions.**	▪ Practice some examples emerging greener technologies analysis achieving. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion ▪ Short Quizzes.
2.3	**To summarize Waste, Production, Problems and Prevention and treatment methods to act as sustainable material in green way.**	▪ Lectures ▪ Oral Discussions. ▪ Brainstorming. ▪ Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion. ▪ Participation.

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
2.4	**To predict Green Chemistry as a tool for more health environment improvement, and its applications, accompanying writing of mini-Reports, operating electronic mail, and Network in communicating with others.**	▪ Group Discussion and Assignments. ▪ Suggest several examples of Green Chemistry as a tool for healthy environment, 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**		
3.1	**To demonstrate scientific research, independently and collaborate with groups in relevant topics.**	▪ Brainstorming. ▪ Exercises ▪ Group Discussion. ▪ Team work.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	**To use all information gained effectively, with research team in class discussions or team works, as well as independently.**	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. ▪ Group Presentation of mini-projects.	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	**Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)**	**weekly**	**30 %**
2	**Midterm Exam**	**7th week**	**30 %**
3	**Final Exam**	**13th week**	**40 %**
4	**Total**		**100%**

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice: • **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;** • **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.** • **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.** • **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***Green Chemistry, an introduction,*** Lancaster, M., R.S.C paperbacks Cambridge, 2002. ISBN-13: 978-1847558732 ***Green Chemistry Education. Changing the Course of Chemistry,*** Anastas, P. T.; Levy, I. J.; Parent, K. E. American Chemical Society 2009, ISBN-13: 978-0841274471
Essential Reference Materials	**None**
Electronic Materials	• Green Chemistry • Environmental Science & Technology • Journal of Hazardous Materials • ACS Sustainable Chemistry & Engineering • Chemosphere • Saudi Digital Library
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites.

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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.
	Course Responsible	**Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد NCAAA

T15

Course Specifications (Postgraduate Degree)

Course Title:	Selected topics in Physical Chemistry
Course Code:	CHM 6249
Program:	Master of Science in Chemistry
Department:	Chemistry
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

Table of Contents

A. Course Identification

1. Credit hours: 5 (5 Lectures, 0 Lab, 0 Tutorials)	
2. Course type ☐ Required ☒ Elective	
3. Level/year at which this course is offered: Level 5/Year 2	
4. Pre-requisites for this course (if any): Advanced Physical Chemistry – CHM 6141	
5. Co-requisites for this course (if any): None	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	60
2	Laboratory/Studio	0
3	Seminars	0
4	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

The course covers selected topics in Physical Chemistry suggested by CGC forward to the approved by the head of department and the department council each time this course is offered.

2. Course Main Objective

At the end of the course, the students will be able to:

- Enable students to enrich their knowledge with different special topics of interest, which are carefully selected from Physical Chemistry topics.
- Learn topics those are not formally offered by the program and receive appropriate academic credit.
- Recognize the hot topics in the Physical chemistry.

3. Course Learning Outcomes

	CLOs	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	To be specified according to the selected topics	Depending on.
1.2		
1.3		
1.4		
2	**Skills:**	
2.1	To be specified according to the selected topics	Depending on.
2.2		
2.3		
2.4		
3	**Values:**	
3.1	To be specified according to the selected topics	Depending on.
3.2		

C. Course Content

No	List of Topics	Contact Hours
1	Specific to Selected topics in Physical Chemistry	60
2		
3		
4		
5		
6		
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and Understanding		
1.1-1.4	To be specified according to the selected topics		
2.0	Skills		
2.1-2-4	To be specified according to the selected topics		
3.0	Values		
3.1- 3.2	To be specified according to the selected topics		

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)	weekly	30 %
2	Midterm Exam	7 th week	30 %
3	Final Exam	13^{th} week	40 %
4	Total		100%

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice: • **Students will be assigned an academic advisor Chemistry Graduate Committee (CGC) to give them the appropriate academic counselling and support;** • **The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.** • **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.** • **A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Chemistry Handbook and Department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	**To be specified according to the selected topics**
Essential Reference Materials	**To be specified according to the selected topics**
Electronic Materials	Saudi Digital Library
Other Learning Materials	• Blackboard • Multimedia associated with the text book and the relevant websites.

2. Educational and research Facilities and Equipment Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology Resources (AV, data show, Smart Board, software, etc.)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	**None**

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation 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 assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Extent of achievement of course learning outcomes	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
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.
	Course Responsible	**Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Council of Chemistry Department**
Reference No.	**10 (No. 2/10)**
Date	**21/04/1444- 15/11/2022**