Course Specification
(Bachelor)

Course Title:	Materials Synthesis and Characterization
Course Code:	CHM 1441
Program:	Bachelor of Science in Chemical Laboratories
Department:	Chemistry
College:	Science
Institution:	Imam Mohammed Ibn Saud Islamic University
Version:	1446-10-v1
Last Revision Date:	1446-10-v1

Table of Contents

A. General information about the course:

1. Course Identification

1. Credit hours: 3 (2, 3, 0)					
3 (2 Lectures, 3 Lab, 0 Tutorials)					
2. Course type					
A.	☐University	☐College	☒ Department	☐Track	☐Others
B.	☒ Required		☐Elective		
3. Level/year at which this course is offered: Level 7/ Fourth year					
4. Course general Description:					
The course covered topics related to different methods of materials synthesis. Characterization Techniques for Chemical and Structural Analyses such as Ultraviolet–Visible Spectroscopy, XRD, XPS, Diffuse Reflectance, FTIR, Raman Spectroscopy. Characterization Techniques for Thermal Analysis. Characterization Techniques for surface Analysis such as Optical Microscopy, Scanning Electron Microscopy, Atomic Force Microscopy and Transmission Electron Microscopy. Applications of materials					
5. Pre-requirements for this course (if any)**:**					
Physical Chemistry- CHM 1346					
6. Co-requisites for this course (if any)**:**					
None					
7. Course Main Objective(s):					

At the end of the course, Students should be able:

- To provide basic knowledge on synthesis and fabrication of materials.
- To understand the surface and thermal characteristics of materials.
- To create awareness on morphology of materials by electron microscopy.
- To understand the principles of X-ray diffraction.
- To acquire knowledge on thermal studies of materials.
- To state the application of materials in the industrial field.

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	**75**	**100%**
2	E-learning	**0**	**0**
3	Hybrid • Traditional classroom • E-learning	**0**	**0**
4	Distance learning	**0**	**0**

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	**30**
2.	**Laboratory/Studio**	**45**
3.	**Field**	**0**
4.	**Tutorial**	**0**
5.	**Others (specify)**	**0**
Total		**75**

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

Code	Course Learning Outcomes	Code of PLOs aligned with program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**To recognize the basic information of nanochemistry and nanomaterials concepts and their applications.**	**K1; K2**	• Six hours weekly, containing lectures and laboratory activities • A Private study, including a Homework	**Direct:** • exams, Quizzes • Homework Laboratory Reports • Participation
1.2	**To provide basic knowledge on synthesis and fabrication of materials.**	**K2; K4**	• Two hours weekly, containing lectures • A Private study, including a Homework	**Direct:** • exams, Quizzes • Oral Discussion • Laboratory Reports • Participation
1.3	**To state the application of nanochemistry and nanotechnology in the industrial field.**	**K1, K2**	• Lectures • laboratory experiment • Group discussion .	**Direct:** • Participation, • Quizzes and MCQs, • Laboratory reports and performance

Code	Course Learning Outcomes	Code of PLOs aligned with program	Teaching Strategies	Assessment Methods
2.0	**Skills**			
2.1	**To differentiate between the different types of nanomaterials, and summarize the nanomaterials synthesis.**	**S1, S2, S3,**	• Lecturing, • group discussion Laboratory experiments performance	**Direct;** • Short quizzes Exams, • Solved problems marks • Homework assignment Laboratory reports
2.2	**To analyze data and results through analytical thinking, with evaluation of the gained information.**	**S1, S2, S3**	• Lecturing, • Group discussion • Laboratory experiments performance	**Direct;** • Short quizzes Exams, • Solved problems marks • Homework assignment Laboratory reports
…	**To develop oral and network communication, technical writing skills through writing, oral presentation of mini reports**	**S3**	• Brain storming • Self-study	**Direct;** • Quizzes • Oral discussion • Laboratory reports
2.4	**To diagram and explain experimentally obtained data during laboratory classes and field tasks, and to demonstrate oral and network communication and technical writing skills.**	**S2; S4**	• Group discussion • Laboratory experiments. • Brain storming	**Direct;** • Homework assignment, • Examination • Laboratory report
3.0	**Values, autonomy, and responsibility**			
3.1	**To appraise teamwork, and**	**V2**	• Group discussions • Homework	Direct:

Code	Course Learning Outcomes	Code of PLOs aligned with program	Teaching Strategies	Assessment Methods
	create awareness to maintain scientific integrity during different assessments, projects, and mini reports.		• Mini reports	• Presentation marks • Oral tests and lab sheets • Assessments and homework
3.2	**Show personal values and attributes such as honesty, empathy and respect for others**	**V1, V2**	Teamwork and class discussions	**Direct** • lab reports • Mini projects
...				

C. Course Content

No	List of Topics	Contact Hours
1.	**Introduction to material synthesis and fabrication:** Synthesis of bulk phase materials-Solid state reaction route, introduction to precipitation & coprecipitation, sol-gel technique, hydrothermal; Semi Conducting materials, metal oxides, etc. Synthesis of nanoparticles-Bottom-Up approach- thin film growth by physical vapour deposition and chemical vapour deposition; Top-down approach- ball milling	6
2.	**Characterization Techniques for Chemical and Structural Analyses:** Ultraviolet–Visible Spectroscopy, X-Ray Diffraction for Material Characterization, X-Ray Photoelectron Spectroscopy, Diffuse Reflectance, Infrared Fourier Transform Spectroscopy, Raman Spectroscopy	6
3.	**Characterization Techniques for Thermal Analysis** Thermogravimetric Analysis, Differential Thermal Analysis, and Differential Scanning Calorimetry	6
4.	**Characterization Techniques for surface Analysis** Textural analysis, Optical Microscopy, Scanning Electron Microscopy, Atomic Force Microscopy and Transmission Electron Microscopy.	6
5.	**Applications of materials:** uses of materials in energy and environemental applications	6
---	**Laboratories Topics**	
1	**Preparation of nanocrystalline NiO catalyst by precipitation method**	3

2	Preparation of nanocrystalline CuO by precipitation method	3
3	Preparation of nanocrystalline CuO-NiO composite catalyst by co-precipitation method	3
4	Preparation of ZnO by thermal decomposition method	3
5	Preparation of $Cu_xCo_{3-x}O_4$ spinel catalyst by co-precipitation method	3
6	Characterization of the prepared catalysts precursors by different spectroscopic techniques (FTIR, XRD, XPS, XRF etc)	3
7	Characterization of the prepared catalysts precursors by different microscopic techniques (AFM, SEM, TEM etc)	3
8	Thermal investigations of the nanostructured composites (TG, DTA, DSC, etc)	3
9	Preparation of ZIF-67 MOF	3
10	Preparation of Co_3O_4@C nanocatalyst by thermal decomposition of ZIF-67 MOF	3
11	Preparation of $ZnFe_2O_4$ spinel by simple impregnation method	3
12	Preparation of graphitic carbon nitride and its composites	3
13	Characterization of the prepared catalysts precursors by FTIR, XRD, TG and DTA	3
14	Porosity assessment of the prepared catalysts	3
15	Revision and Lab. Reports Overview	3
	Total	75

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	Midterm 1	6^{th}/ 7^{th} week	10 %
2.	Midterm 2	11^{th}/ 12^{th} week	10 %
3.	Quizzes, Home Works, class participation, and mini projects	During the semester	10 %
4.	Laboratory	All the semester	30 %
5.	Final Exam	16^{th}week	40 %
6.	Total	All weeks	100 %

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

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	**Material Characterization Techniques and Applications,** Euth Ortiz Ortega, Hamed Hosseinian, Ingrid Berenice Aguilar Meza, María José Rosales López, Andrea Rodríguez Vera, Samira Hosseini, (2022) 1st Ed. Springer Singapore, eBook ISBN 978-981-16-9569-8
Supportive References	**Characterization of Materials**, Elton N. Kaufmann, 2nd Edition (2012) Wiley, ISBN: 978-1-118-11074-4
Electronic Materials	
Other Learning Materials	

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	• Each of the class room should be equipped with a whiteboard and a projector, with a maximum of 20 students. • In each laboratory, a list of safety and precautions are provided. • In each lab has proper ventilation, and well equipped with instruments. • In each lab, containers for solid waste, liquid waste, and crushed glasses. • Each lab has a small pharmacy for first aid in case of an accident • In each lab, the rules, conditions, and safety mechanism as well list of Risk, Safety precautions according to Merck Catalogue are hanging in the labs
Technology equipment (projector, smart board, software)	The rooms are equipped with data show, Smart Board, WI-FI access.
Other equipment (depending on the nature of the specialty)	• Appropriate Glasswares for carrying the requested experiments (conical flasks, beakers, measuring cylinders) • Appropriate fine chemicals and solvents (distilled Water ammonium nitrate) • Analytical balance (3 digits), Set gas laws with the glass jacket Data acquisition set for gas laws with glass jacket, PC, Windows® 95 or higher,

Items	Resources
	calorimeter, thermometer, Filter papers , clamps, stands

F. Assessment of Course Quality

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

Assessors (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	COUNCIL OF DEPARTMENT OF CHEMISTRY
REFERENCE NO.	3 (NO. 1/3)
DATE	5/3/1446- 8/09/2024