CHEM4084: CRYSTALLOGRAPHY/SOLID-STATE INORGANIC CHEMISTRY

Effective Term
Semester A 2024/25

Part I Course Overview

Course Title
Crystallography/Solid-state Inorganic Chemistry

Subject Code
CHEM - Chemistry
Course Number
4084

Academic Unit
Chemistry (CHEM)

College/School
College of Science (SI)

Course Duration
One Semester

Credit Units
4

Level
B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
CHEM2006/BCH2006 (Principles of Inorganic Chemistry)

Precursors
Nil

Equivalent Courses
BCH4084 Crystallography/Solid-state Inorganic Chemistry

Exclusive Courses
Nil

Part II Course Details

Abstract

This is an interdisciplinary course on the fundamental and contemporary topics of crystallography and crystal structures, properties and technological applications. As the subject matter is not usually covered in an undergraduate curriculum, brief and intuitive introduction to the structures and properties of solid state materials will be presented on a level accessible for students in year two or above. Exemplary chapters including basic X-ray diffraction theory for structural studies, common structural types of inorganic solids, zeolite materials and recent advances in organic-inorganic porous materials, plasmonic materials, synthesis of solid state materials and their uses in energy, biomedical, electronic and environmental technologies. These technologies include: environmentally friendly catalysts, sensors, and low-cost fabrication of devices such as field effect transistors (FET), light-emitting diodes (LED), solar cells and fuel cells. We will also discuss the frequently used chemical reactions in the fabrication process of these materials.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Carry out basic analysis of the concepts and principles in the X-ray diffraction studies on solid state material.	25	x		
2	Implement reliable and appropriate intellectual procedures for correlating crystalline structures to materials properties, and reliably implement it with accuracy and precision.	25		x	
3	Critically evaluate experiments/processes in the preparation and applications of solid state materials/nanomaterials in the chemical literature and effectively communicate this knowledge within their special study fields.	25	x	x	x
4	Identify and uphold the social responsibilities of chemists, with particular concern for biomedical and environmental issues in the solid state and nanomaterials research.	25		x	x

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures and tutorials	In a combination of lectures and tutorials student will learn to elucidate the fundamental and contemporary topics of crystallography and crystal structures, properties and technological applications of solid-state inorganic materials.	1, 2	
2	Lectures	Students will primarily be engaged in the case studies of the important types of structures and properties of solid-state materials, including basic X-ray diffraction theory, inorganic solids, zeolite materials, organic-inorganic porous materials, plasmonic materials, and their uses in energy, biomedical, electronic and environmental technologies.	1, 2	
3	Group activities, Written assignments, presentations	Students will participate in large and small group activities examining various molecules/ materials/ procedures, and the implications in modern technology development. Team work is emphasized in the form of group presentation and assignment of selected projects.	3, 4	
4	Tutorials and recent primary research articles	Students will develop independent and critical thinking through extensive teacher-student interaction and supervised in-depths discussion among the students based on recent primary research articles.	1, 4	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Tutorial Assignments or Quizzes	1, 2, 3, 4	20	
2	Group Presentations and reports	3, 4	20	

Continuous Assessment (%)

40

Examination (%)

60

Examination Duration (Hours)

3

Additional Information for ATs

Starting from Semester A, 2015-16, students must satisfy the following minimum passing requirement for courses offered by CHEM: "A minimum of 40% in both coursework and examination components."

Assessment Rubrics (AR)

Assessment Task

1. Tutorial Assignments or Quizzes

Criterion

Ability to express, explain and apply the core concepts and equations in the covered subjects of crystallography and solid-state inorganic chemistry.

Excellent (A+, A, A-)

Be able to demonstrate a strong grasp of essential concepts in crystallography and solid-state inorganic chemistry, understande different lattice structures, symmetry elements, and basic crystallographic calculations, explain these concepts with deep understanding of these concepts

Good (B+, B, B-)

Be able to express, explain, and apply the core concepts and equations in the covered subjects of crystallography and solid-state inorganic chemistry.

Fair (C+, C, C-)

Be able to demonstrate a basic level of understanding of fundamental concepts such as lattice structures, unit cells, and crystallographic symmetry

Marginal (D)

Be able to show only a limited understanding of key foundational concepts such as lattice types, crystal symmetry, and basic crystallographic calculations

Failure (F)

Inadequate understand and express Core Concepts; Failure to apply equations and theoretical knowledge

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Assessment Task

2. Group presentations and reports

Criterion

Clear presentation indicative of critical and logical thinking. Ability to enhance the group-works experience, organize a presentation with cohesive content, to analyse and evaluate and scientific problem/issues.

Excellent (A+, A, A-)

Be able to enhance the group-works experience, organize a presentation with cohesive content, to analyze and evaluate a scientific problem/issues, and thhe presentations were well-structured, with logical flow and clarity that facilitated easy understanding, thus reflecting deep critical and logical thinking.

Good (B+, B, B-)

Be able to demonstrate clear and competent presentation skills, effectively communicating the main concepts and details of their topic, work well with others and contributed ideas that generally enhanced the group's output.

Fair (C+, C, C-)

Be able to communicate adequately but not particularly influential, participate in group activities and contributed to discussions, but not significantly drive the group's progress or introduce innovative ideas.

Marginal (D)

Only be able to apply basic concepts to communicate , the presentations sometimes suffered from issues such as insufficient detail, rushed delivery, or a lack of engaging delivery techniques.

Failure (F)

Lack clarity, structure, and engagement. the student's contribution was minimum and did not enhance the group-work experience

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Assessment Task

3. Final examination

Criterion

Ability to tackle the designer problems on crystallography and crystal structures of solid-state materials utilizing the firm grip on the acquired core concepts and topical contents.

Excellent (A+, A, A-)

Be able to demonstrate a deep understanding and mastery of core concepts in crystallography and the crystal structures of solid-state materials, express a comprehensive grasp of the subject matter, allowing to engage with complex problems effortlessly

Good (B+, B, B-)

Be able apply key principles correctly, though occasionally they might have missed subtle details or depth that could have enriched their answers, approach problems methodically and provide logical solutions.

Fair (C+, C, C-)

Be able to address some of the simpler aspects of the problems correctly, there was a lack of depth and completeness in their comprehension and application, attempt to solve the designer problems but often resorted to simplistic or generic solutions.

Marginal (D)

Only show an incomplete understanding of the fundamental concepts related to crystallography and the crystal structures of solid-state materials. The student's problem-solving skills were found to be basic and often ineffective for the complexity of designer problems presented in the examination

Failure (F)

Deficiently understand the essential concepts critical to crystallography and the crystal structures of solid-state materials. Problem-solving skills were markedly ineffective, with the student often failing to formulate coherent strategies or logical solutions

Part III Other Information

Keyword Syllabus

Solids and society. Industrial and environmental importance of solid state materials. Crystal structures, packing of molecules, basic diffraction theory. Properties of solids: porosity, conductivity and semiconductivity, luminescence, and plasmonics. Applications of solids: catalysts, field effect transistors, light-emitting diodes, solar cells, fuel cells, environment sensors, biomedical sensors. Preparation of inorganic-based solids and nano-particles&-materials and methods of crystal growth.

Reading List

Compulsory Readings

	Title
1	The solid state : A. Guinier and R. Jullien, Oxford University Press, 1989.
2	Introduction to Crystallography: D. E. Sands. Dover Publications, 1993
3	Appropriate Selected Research Papers
4	NOTE:# These books are only recommended for reading and should NOT be purchased without consulting your lecturer.

Additional Readings

	Title
1	Nil