



# Course Specification

Diploma

Course Title: Crystallography and Mineralogy

Course Code: APMQ1202

Program: Mining and Quarrying

Department: Diploma Department

College: The Applied College

Institution: Umm Al-Qura University

Version: 1

Last Revision Date: 20 February 2025

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## A. General information about the course:

### 1. Course Identification

#### 1. Credit hours:

3 hours

#### 2. Course type

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

#### 3. Level/year at which this course is offered: ( 1 St. Level)

#### 4. Course General Description:

The Crystallography and Mineralogy course is a core component of geology, mining, and materials science programs. It introduces students to the study of minerals, their properties, classification, internal structure (crystallography), and their role in Earth's processes and industrial applications.

Crystallography: Definition and crystal parts, interfacial angles and their law, crystallographic elements, crystal symmetry, crystal habit and forms, crystal aggregates, crystal systems, holohedral and hemihedral forms, **hemi morphism** and enantiomorphism, axial ratios-crystal parameters and Miller indices, zone, zone axes and zone symbols and law. General description of the crystal systems. Stereographic projection. Practical examination of models representing crystal forms of seven crystal systems.

Mineralogy: Definitions – Physical and chemical properties of minerals – Chemical compositions – Origin of minerals – Classification of minerals – Minerals of the Earth's crust – Mineral associations in rocks and ore deposits - Description of crystal forms; genesis, field occurrences and uses of some important minerals. Laboratory investigation of hand specimens representing the major mineral groups.

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

None

#### 6. Co-requisites for this course (if any):

None

#### 7. Course Main Objective(s):



### 1. Understand the Nature and Properties of Minerals

- Define what a mineral is and describe its physical and chemical characteristics.
- Identify key physical properties of minerals (e.g., hardness, luster, color, cleavage, density).

### 2. Classify Minerals into Major Groups

- Learn the chemical classification of minerals (silicates, carbonates, oxides, sulfides, halides, etc.).
- Understand the structure, composition, and occurrence of common rock-forming and ore minerals.

### 3. Explore Crystallography Fundamentals

- Understand the internal atomic structure of minerals and how it relates to their external crystal form.
- Learn about crystal systems, symmetry elements, and crystal classes.
- Use crystallographic axes and Miller indices to describe crystal faces and forms.

### 4. Develop Mineral Identification Skills

- Practice mineral identification using hand specimens and physical tests.
- Learn basic techniques using tools like the Mohs hardness scale, streak plate, and hand lens.

### 5. Learn Optical and X-ray Methods for Mineral Study

- Introduction to optical mineralogy: use of polarizing microscope for thin section analysis.
- Basic understanding of X-ray diffraction (XRD) for determining crystal structures.

### 6. Understand the Formation and Occurrence of Minerals

- Explore the processes of mineral formation in different geological environments (igneous, sedimentary, metamorphic).
- Understand how minerals relate to specific rock types and geological settings.

### 7. Apply Knowledge to Practical and Industrial Contexts

- Recognize the importance of minerals in natural resource exploration, mining, and materials science.
- Understand the industrial and economic uses of key minerals (e.g., quartz, feldspar, calcite, gypsum).

### 8. Interpret Mineralogical Data

- Analyze and interpret data from crystal structure diagrams, stereographic projections, and mineral charts.
- Apply mineralogical concepts to real-world geological problems and case studies.

## 2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	E-learning		
3	Hybrid <ul style="list-style-type: none"> <li>Traditional classroom</li> <li>E-learning</li> </ul>		
4	Distance learning		

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

No	Activity	Contact Hours
1.	Lectures	60
2.	Laboratory/Studio	
3.	Field	
4.	Tutorial	
5.	Others (specify)	
Total		45

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

1.0	Knowledge and understanding			
1.1	Learn the chemical classification of minerals (silicates, carbonates, oxides, sulfides, halides, etc.).	K1	Lectures and Interactive Discussions	Written Exams (Mid-Term and Final Exams), Quizzes.
1.2	Understand the structure, composition, and occurrence of common rock-forming and ore minerals.	K2	Lectures and Interactive Discussions	Written Exams (Mid-Term and Final Exams), Quizzes.
1.3	Understand the internal atomic structure of minerals and how it relates to their external crystal form.	K23	Lectures and Interactive Discussions	Written Exams (Mid-Term and Final Exams), Quizzes.
2.0	Skills			



2.1	Use crystallographic axes and Miller indices to describe crystal faces and forms. Recognize the importance of minerals in natural resource exploration, mining, and materials science.	<b>S1</b>	Interactive Discussions	Written Exams (Mid-Term and Final Exams), Quizzes
2.2	Practice mineral identification using hand specimens and physical tests.	<b>S3</b>	Interactive Discussions	Written Exams (Mid-Term and Final Exams), Quizzes
3.2	Recognize the importance of minerals in natural resource exploration, mining, and materials science.	<b>S2</b>	Interactive Discussions	Written Exams (Mid-Term and Final Exams),
<b>3.0</b>	<b>Values, autonomy, and responsibility</b>			
3.1	Work cooperatively in a small group environment, Analyze and interpret data from crystal structure diagrams, stereographic projections, and mineral charts.	<b>V1</b>	Individual and Group Presentations	Presentations

### C. Course Content

No	List of Topics	Contact Hours
1.	Introduction to Mineralogy, Definition of minerals, mineral properties, historical significance	2
2.	Physical Properties of Minerals, Hardness, color, streak, luster, cleavage, fracture, density	2
3.	Mineral Classification, Silicates vs non-silicates, mineral families	2
4.	Introduction to Crystallography, Crystal lattice, unit cells, crystal growth	2
5.	Crystal Systems and Symmetry, 7 crystal systems, symmetry elements, crystal classes	2
6.	Miller Indices, Notation for crystal planes, face orientation	2
7.	Polymorphism & Isomorphism, Mineral variations, solid solutions	2
8.	Optical Mineralogy I, Introduction to polarizing microscope, isotropic vs anisotropic	2
9.	Optical Mineralogy II, Interference colors, birefringence, extinction angles	2
10.	X-ray Crystallography, Basics of XRD, diffraction patterns, mineral analysis	2



11.	Rock-Forming Minerals, Feldspars, quartz, olivine, pyroxenes, amphiboles	2
12.	Ore Minerals and Economic Significance, Galena, sphalerite, magnetite, chalcopryrite	2
13.	Mineral Formation Environments, Igneous, sedimentary, and metamorphic origins	2
14.	Field Identification Techniques, Using tools in the field: hand lens, hardness kits, streak plates	2
15.		2
Total		30

## C.2 Experimental Content

No	List of Topics	Contact Hours
3.	Introduction to Lab Safety and Equipment Safety protocols in handling minerals and acids Introduction to lab tools: hand lens, streak plate, hardness kit, glass plate, magnet Overview of mineral samples and storage techniques	2
3.	Physical Properties of Minerals (Part I) Observe: Color, luster, streak	2
4.	Practice with streak plates and luster determination Record and describe findings using standard identification tables	2
5.	Physical Properties of Minerals (Part II)	2
6.	Perform hardness tests using the Mohs hardness scale	2
7.	Examine cleavage, fracture, specific gravity Simple reaction tests with HCl for carbonates (e.g., calcite)	2
8.	Crystal Forms and Symmetry	2
9.	Study natural crystal samples and crystal models	2
10.	Introduction to symmetry elements (axes, planes, center of symmetry) Determine symmetry elements and identify crystal classes	2
11.	Crystal Systems and Miller Indices Classification of crystals into the 7 systems	2
12.	Use 3D models and diagrams to learn axial relationships Introduction to Miller Indices and practice calculating them	2
13.	Silicate Mineral Identification	2
14.	Focus on quartz, feldspar, mica, olivine, pyroxenes, amphiboles Classify based on silicate structures (isolated, chain, sheet, framework)	2
Total		28

## D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	Quizzes	5	10
2.	Mid-Term Exam	8	20
3.	Presentations	12	10
4.	Homework	All weeks	10
5.	Final Exam	16	50

\*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	Crystallography and Crystal Chemistry, F. Donald Bloss Optical Mineralogy: Principles and Practice, C.D. Gribble & A.J. Hall Introduction to Crystallography, Donald E. Sands
Supportive References	
Electronic Materials	<a href="https://www.mindat.org">https://www.mindat.org</a> The world's largest database of minerals and mineral locality information, used by both students and professionals. <a href="http://webmineral.com">http://webmineral.com</a> Mineral data sheets, crystallographic data, and physical properties. Mineralogy Database (U.S. Geological Survey) – <a href="https://www.usgs.gov">https://www.usgs.gov</a> For accessing mineral resources, research publications, and mapping tools.
Other Learning Materials	

### 2. Required Facilities and equipment

Items	Resources
<b>facilities</b> (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	Classrooms
<b>Technology equipment</b> (projector, smart board, software)	Data show





Items	Resources
<b>Other equipment</b> (depending on the nature of the specialty)	

## F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Faculty	Direct (project, HW, Quiz, midterm and final exam)
Effectiveness of Students assessment	Students	Indirect (Student Survey)
Quality of learning resources	Program Coordinator	Direct analysis
The extent to which CLOs have been achieved	Program Coordinator	Direct analysis
Other		

**Assessors** (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify))

**Assessment Methods** (Direct, Indirect)

## G. Specification Approval

<b>COUNCIL /COMMITTEE</b>	Umm Al-Qura University Council
<b>REFERENCE NO.</b>	851110214476/195605
<b>DATE</b>	18/2/1447

