| Form: Course Syllabus | | |
|---|---|---|
| | **Form Number** | EXC-01-02-02A |
| | **Issue Number and Date** | 2/3/24/2022/2963 05/12/2022 |
| | **Number and Date of Revision or Modification** | |
| | **Deans Council Approval Decision Number** | 2/3/24/2023 |
| | **The Date of the Deans Council Approval Decision** | 23/01/2023 |
| | **Number of Pages** | 06 |

| | | |
|---|---|---|
| **1.** | **Course Title** | X-ray Crystallography and Structure Determination |
| **2.** | **Course Number** | 0303722 |
| **3.** | **Credit Hours (Theory, Practical)** | (3,0) |
| | **Contact Hours (Theory, Practical)** | (3,0) |
| **4.** | **Prerequisites/ Corequisites** | - |
| **5.** | **Program Title** | Master in Chemistry |
| **6.** | **Program Code** | 0303 |
| **7.** | **School/ Center** | Science |
| **8.** | **Department** | Chemistry |
| **9.** | **Course Level** | Master (including PhD students) |
| **10.** | **Year of Study and Semester (s)** | 2nd semester 2023/2024 |
| **11.** | **Other Department(s) Involved in Teaching the Course** | - |
| **12.** | **Main Learning Language** | English |
| **13.** | **Learning Types** | **x** Face to face learning ☐Blended ☐Fully online |
| **14.** | **Online Platforms(s)** | ☐Moodle **x** Microsoft Teams |
| **15.** | **Issuing Date** | 3-11-2023 |
| **16.** | **Revision Date** | 9-11-2024 |

**17. Course Coordinator:**

| | |
|---|---|
| Name: Prof. Dr. Murad A. AlDamen | Contact hours: 8:00-10:00 Mon. Wed. |
| Office number: Chemistry 2nd floor | Phone number: N/A |
| Email: maldamen@ju.edu.jo | |

**18. Other Instructors:**

| |
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| |

**19. Course Description:**

| Course Description |
| --- |
| This course covers the study of X-ray diffraction and its relationship with crystals to determine the structural composition of crystalline compounds. It focuses on essential topics such as crystal lattices, crystallographic systems, space groups, and deriving different positions within the crystal structure. The course also explores the concept of the reciprocal lattice, techniques for collecting boundary information and analyzing it, as well as key structural elements and Fourier transforms. It delves into phase problems, Patterson methods, and the heavy-atom method, with an emphasis on innovative approaches to solving phase issues.<br><br>The practical component of the course involves hands-on training using advanced techniques and modern software. By the end of the practical sessions, students will solve the crystal structure of a single-crystal compound, providing them with advanced practical experience in crystallography and X-ray analysis for single crystals. |

**20. Program Student Outcomes (SO's):** (To be used in designing the matrix linking the intended learning outcomes of the course with the intended learning outcomes of the program)

SO1. Demonstrate comprehensive knowledge and understanding of chemistry topics, achieving expertise in foundational research principles.

SO2. Develop independent research skills to solve complex problems, focusing on analytical and critical thinking.

SO3. Improve communication of scientific knowledge through structured reports, presentations, and discussions.

SO4. Engage in activities that enhance practical scientific skills and improve professional expertise.

SO5. Maintain ethical standards in research.

**21. Course Intended Learning Outcomes (CLO's):** (Upon completion of the course, the student will be able to achieve the following intended learning outcomes)

**1. Understand the fundamental concepts of solid-state chemistry, including crystal systems, geometry, and space groups**

**2. Understand the fundamental concepts of X-ray techniques, especially single Xray Crystallography.**

**3. Apply X-ray diffraction techniques to analyze crystal structures and determine atomic positions**

**4. Interpret and communicate scientific data from X-ray diffraction experiments**

**5. Adhere to ethical standards in conducting practical experiments and reporting research findings**

| Course CLOs | The learning levels to be achieved | | | | | |
|---|---|---|---|---|---|---|
| | Remembering | Understanding | Applying | Analysing | evaluating | Creating |
| 1 | | ✓ | | | | |
| 2 | | ✓ | | | | |
| 3 | | | ✓ | | | |
| 4 | | | | ✓ | ✓ | ✓ |
| 5 | | | ✓ | ✓ | ✓ | ✓ |

**22. The matrix linking the intended learning outcomes of the course with the intended learning outcomes of the program:**

| Program SO's / Course CLO's | SO (1) | SO (2) | SO (3) | SO (4) | SO (5) |
|---|---|---|---|---|---|
| CLO 1 | ✓ | | | | |
| CLO 2 | ✓ | | | | |
| CLO 3 | | ✓ | | ✓ | |
| CLO 4 | | | ✓ | | |
| CLO 5 | | | | | ✓ |

**23. Topic Outline and Schedule:**

| Week | Lecture | Topic | CLO/s Linked to the Topic | Learning Types Face to Face (FF) Blended (BL) | Platform Used | Synchronous (S) | Evaluation Methods | Learning Resources* |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.1 | Introduction to solid state | 1,2 | FF | In class | S | MID, Final | |
| | 1.2 | Introduction to solid state | 1,2 | FF | In class | S | MID, Final | |
| | 1.3 | Introduction to solid state | 1,2 | FF | In class | S | MID, Final | |
| 2 | 2.1 | X-ray diffraction | 1,2 | FF | In class | S | MID, Final | |
| | 2.2 | X-ray diffraction | 1,2 | FF | In class | S | MID, Final | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2.3 | X-ray diffraction | 1,2 | FF | In class | S | MID, Final | |
| 3 | 3.1 | Crystal Systems and Geometry | 1,2 | FF | In class | S | MID, Final | |
| | 3.2 | Crystal Systems and Geometry | 1,2 | FF | In class | S | MID, Final | |
| | 3.3 | Crystal Systems and Geometry | 1,2 | FF | In class | S | MID, Final | |
| 4 | 4.1 | Space Groups and Equivalent Positions | 1,2 | FF | In class | S | MID, Final | |
| | 4.2 | Space Groups and Equivalent Positions | 1,2 | FF | In class | S | MID, Final | |
| | 4.3 | Space Groups and Equivalent Positions | 1,2 | FF | In class | S | MID, Final | |
| 5 | 5.1 | Space Groups and Equivalent Positions | 1,2 | FF | In class | S | MID, Final | |
| | 5.2 | Space Groups and Equivalent Positions | 1,2 | FF | In class | S | MID, Final | |
| | 5.3 | Space Groups and Equivalent Positions | 1,2 | FF | In class | S | MID, Final | |
| 6 | 6.1 | Diffraction and crystal structures | 1,2 | FF | In class | S | Quiz, Final | |
| | 6.2 | Diffraction and crystal structures | 1,2 | FF | In class | S | Quiz, Final | |
| | 6.3 | Diffraction and crystal structures | 1,2 | FF | In class | S | Quiz, Final | |
| 7 | 7.1 | Diffraction and crystal structures | 1,2 | FF | In class | S | Quiz, Final | |
| | 7.2 | Diffraction and crystal structures | 1,2 | FF | In class | S | Quiz, Final | |
| | 7.3 | Diffraction and crystal structures | 1,2 | FF | In class | S | Quiz, Final | |
| 8 | 8.1 | Diffraction and crystal structures | 1,2 | FF | In class | S | Quiz, Final | |
| | 8.2 | Diffraction and crystal structures | 1,2 | FF | In class | S | Quiz, Final | |
| | 8.3 | Diffraction and crystal structures | 1,2 | FF | In class | S | Quiz, Final | |
| 9 | 9.1 | Determination of Atomic Positions | 3 | FF | In class | S | Quiz, Final | |
| | 9.2 | Determination of Atomic Positions | 3 | FF | In class | S | Quiz, Final | |
| | 9.3 | Determination of Atomic Positions | 3 | FF | In class | S | Quiz, Final | |
| 10 | 10.1 | Determination of Atomic Positions | 3 | FF | In class | S | Quiz, Final | |
| | 10.2 | Determination of Atomic Positions | 3 | FF | In class | S | Quiz, Final | |
| | 10.3 | Determination of Atomic Positions | 3 | FF | In class | S | Quiz, Final | |
| 11 | 11.1 | Determination of Atomic Positions | 3 | FF | In class | S | Quiz, Final | |
| | 11.2 | Determination of Atomic Positions | 3 | FF | In class | S | Quiz, Final | |
| | 11.3 | Determination of Atomic Positions | 3 | FF | In class | S | Quiz, Final | |
| 12 | 12.1 | Practical Work | 4,5 | FF | In class | S | Practical | |
| | 12.2 | Practical Work | 4,5 | FF | In class | S | Practical | |
| | 12.3 | Practical Work | 4,5 | FF | In class | S | Practical | |
| 13 | 13.1 | Practical Work | 4,5 | FF | In class | S | Practical | |
| | 13.2 | Practical Work | 4,5 | FF | In class | S | Practical | |
| | 13.3 | Practical Work | 4,5 | FF | In class | S | Practical | |
| 14 | 14.1 | Practical Work | 4,5 | FF | In class | S | Practical | |
| | 14.2 | Practical Work | 4,5 | FF | In class | S | Practical | |
| | 14.3 | Practical Work | 4,5 | FF | In class | S | Practical | |
| 15 | 15.1 | Practical Work | 4,5 | FF | In class | S | Practical | |
| | 15.2 | Practical Work | 4,5 | FF | In class | S | Practical | |
| | 15.3 | Practical Work | 4,5 | FF | In class | S | Practical | |

* different resources mentioned in the reference section

## 24. Evaluation Methods:

Opportunities to demonstrate the achievement of the CLOs are provided through the following assessment methods and requirements:

| Evaluation Activity | Mark | Topic(s) | CLO/s Linked to the Evaluation activity | Period (Week) | Platform |
|---|---|---|---|---|---|
| Mid | 30 | As per Sec. 21 above | 1,2,3 | Week 8 | |
| Quiz | 15 | As per Sec. 21 above | 1,2,3 | Week 12 | |
| Practical | 15 | As per Sec. 21 above | 4,5 | After week 12 | |
| Final Exam | 40 | As per Sec. 21 above | 1,2,3 | TBD | |

## 25. Course Requirements:

International Tables for Crystallography: ISBN: 978-0-470-68575-4, https://doi.org/10.1107/97809553602060000001

https://www.olexsys.org/olex2/ package

## 26. Course Policies:

A- Attendance policies:

B- Absences from exams and submitting assignments on time:

C- Health and safety procedures:

D- Honesty policy regarding cheating, plagiarism, misbehavior:

E- Grading policy:

F- Available university services that support achievement in the course:

## 27. References:

A- Required book (s), assigned reading and audio-visuals:

1. Introduction to Crystallography, by Donald E. Sands.
2. X-ray Structure Determination, by George H. Stout and Lyle H. Jensen.
3. Crystallography and its applications, by L. S. D. Glasser

Recommended books, materials, and media:

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| The International Tables for X-ray Crystallography. Other reference textbooks by Bunn, Buerger, Glasser, Wheatley, and others in the field may be found in the library |

**28. Additional information:**

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|---|---|---|
| Name of the Instructor or the Course Coordinator:<br>**Dr. Murad AlDamen, Prof.** | Signature:<br>……...…… | Date:<br>……..…… |
| The Head of Graduate Studies Committee/ Department Chemistry<br>**Dr. Murad AlDamen, Prof.** | Signature:<br>……...…… | Date:<br>……..…… |
| The Head of Department of Chemistry<br>**Dr. Murad AlDamen, Prof.** | Signature:<br>……...…… | Date:<br>……..…… |
| Vice Dean for Graduate Studies and Scientific Research / School of Science<br>**Dr. Kamal Sweidan, Prof.** | Signature:<br>……...…… | Date:<br>……..…… |
| The Dean of School of Science<br>**Dr. Mahmoud I. Jaghoub, Prof.** | Signature:<br>……...…… | Date:<br>……..…… |