جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology

Course Syllabus: Crystallography and Diffraction - MSE 221

Division	Physical Science and Engineering Division
Course Number	MSE 221
Course Title	Crystallography and Diffraction
Academic Semester	Spring
Academic Year	2018/2019
Semester Start Date	01/27/2019
Semester End Date	05/23/2019
Class Schedule (Days & Time)	02:30 PM - 04:00 PM | Sun Mon

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Xixiang Zhang	xixiang.zhang@kaust.edu.sa	+966128082332	2218, 3, Ibn Sina (bldg. 3)	By appointment

Teaching Assistant(s)

Name	Email
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Course Information

Comprehensive Course Description	MSE221 – Crystallography and Diffraction is one of the Core Courses of the MSE Program. MSE221 covers the basic concepts necessary to determine and describe the crystal structure of materials to the techniques used to examine it. Firstly, the different degrees of structural order in matter are presented and how one can define the subject of Crystallography. Next, revisions on what wave-particle duality is, the electronic configuration of elements and what constitutes a bond are made. The unit cell, crystallographic planes, Bravais lattice, atomic packing factor and dislocations in crystals will be amongst the notions used to latter define how physical properties may be influenced by variations in the crystal structure of materials. Symmetry and elements pertaining to symmetry operations will help establish the different point, plane and space groups that lattices can be classified into. Following this, the crystal structure will be studied looking at how real and reciprocal lattices relate. Here, concepts such as Wigner-Seitz cells and the first Brillouin zone will be approached. The principles of diffraction and how these correlate to different types of electromagnetic waves and particles, from light to X-rays, electrons and neutrons will be addressed. Bragg's law, the Ewald sphere and structure factor are amongst the topics to study. Finally, several case studies such as the assignment of electron diffraction patterns will be used to illustrate the capabilities of each diffraction technique.
Course Description from Program Guide	The objective of this course is to present the basic concepts needed to understand the crystal structure of materials. Fundamental concepts including lattices, symmetries, point groups, and space groups will be discussed and the relationship between crystal symmetries and physical properties will be addressed. The theory of X-ray diffraction by crystalline matter along with the experimental x-ray methods used to determine the crystal structure of materials will be covered. Application of X-ray diffraction to proteins, electron diffraction and neutron diffraction will be briefly discussed.
Goals and Objectives	At the end of this course students should be able to: •Define concepts such as lattice, point and space groups •Be familiar with Bragg's Law and explain its relation to crystal structure •Identify and describe different diffraction methods •Interpret and assign X-ray and electron diffraction patterns

Required Knowledge	Students are expected to have successfully completed, or be familiar with the contents of, Fundamentals of Materials Science Helpful background reading about materials: *Materials Science and Engineering: An Introduction* (7th. Ed.), by W. D. Calister, John Wiley and Sons; ISBN: 0-471-73696-1.
Reference Texts	Primary: C. Hammond, *The Basics of Crystallography and Diffraction*, Oxford University Press, 2009. Secondary: G.S. Rohrer, *Structure and Bonding in Crystalline Materials*. Cambridge University Press, 2001.
Method of evaluation	**10.00**% - Oral presentation **25.00**% - Midterm exam **25.00**% - Homework /Assignments **40.00**% - Final exam
Nature of the assignments	The student will be expected to read the primary textbook in advance of lectures. A number of homeworks will be given during the semester and the student will be expected to give a presentation on an advanced topic related to the course, for which there will be time set aside during class hours for guidance.
Course Policies	The graduate student is expected to be independent and get more information by him/herself. Plagiarism and references: Always cite references and attribute the work. Students should attend all lectures. Frequent absence will be penalized up to 5% of the final grade).
Additional Information	The instructors reserve the right to make changes to the syllabus and schedule of lectures.

Tentative Course Schedule *(Time, topic/emphasis & resources)*		
Week	**Lectures**	**Topic**
1	Sun 01/27/2019	Discussion of syllabus and introduction to crystallography
1	Mon 01/28/2019	Materials background I
2	Sun 02/03/2019	Materials background II
2	Mon 02/04/2019	1D and 2 D patterns, lattices and symmetries
3	Sun 02/10/2019	Bravais lattices and their symmetries I
3	Mon 02/11/2019	Bravais lattices and their symmetries II
4	Sun 02/17/2019	Crystal symmetry, point groups and space groups I
4	Mon 02/18/2019	Crystal symmetry, point groups and space groups II
5	Sun 02/24/2019	Crystal symmetry, point groups and space groups III
5	Mon 02/25/2019	Crystal symmetry, point groups and space groups IV
6	Sun 03/03/2019	Discussion of topical projects I
6	Mon 03/04/2019	Session with librarian (tentative)
7	Sun 03/10/2019	Classroom exercise session
7	Mon 03/11/2019	Mid-term exam
8	Sun 03/17/2019	Properties of crystals
8	Mon 03/18/2019	Reciprocal lattice I
9	Sun 03/24/2019	Reciprocal lattice II
9	Mon 03/25/2019	Discussion of topical projects II
10	Sun 03/31/2019	Spring Break
10	Mon 04/01/2019	Spring Break
11	Sun 04/07/2019	Diffraction of X-rays I
11	Mon 04/08/2019	Diffraction of X-rays II
12	Sun 04/14/2019	Electron diffraction I
12	Mon 04/15/2019	Electron diffraction II
13	Sun 04/21/2019	Electron diffraction III
13	Mon 04/22/2019	Neutron diffraction
14	Sun 04/28/2019	Discussion of topical project III
14	Mon 04/29/2019	Practical aspects of X-ray diffraction I
15	Sun 05/05/2019	Practical aspects of X-ray diffraction II
15	Mon 05/06/2019	Student presentations I
16	Sun 05/12/2019	Student presentations II
16	Mon 05/13/2019	Student presentations III
17	Sun 05/19/2019	Final Exam Week
17	Mon 05/20/2019	Final Exam Week

Note

The instructor reserves the right to make changes to this syllabus as necessary.