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	Fall
Academic Year	2019/2020
Semester Start Date	08/25/2019
Semester End Date	12/10/2019
Class Schedule (Days & Time)	09:00 AM - 10:30 AM | Wed , 02:30 PM - 04:00 PM | Mon

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Pedro Miguel Da Costa	Pedro.DaCosta@KAUST.EDU.SA	+966128084453	3336, 3, Ibn Sina (bldg. 3)	By appointment.

Teaching Assistant(s)

Name	Email
n.a.	n.a.

Course Information

Comprehensive Course Description	MSE221 – Crystallography and Diffraction is one of the Core Courses of the MSE Program. MSE221 covers from 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 crystals 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 correlated 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 General Chemistry (KAUST 100-level class), General Physics (KAUST 100-level class) and Fundamentals of Materials Science (KAUST 200-level class). 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 **30.00**% - Midterm exam **20.00**% - Homework /Assignments **40.00**% - Final exam
Nature of the assignments	The student will be expected to read the primary textbook in advance of lectures. Two 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 may be penalized up to 5% of the final grade.
Additional Information	The instructor reserves the right to make changes to the syllabus and schedule of lectures.

Tentative Course Schedule *(Time, topic/emphasis & resources)*		
Week	**Lectures**	**Topic**
1	Mon 08/26/2019	Discussion of syllabus and introduction to crystallography
1	Wed 08/28/2019	Materials background I
2	Mon 09/02/2019	Materials background II
2	Wed 09/04/2019	1D and 2 D lattices and their symmetries
3	Mon 09/09/2019	3D (Bravais) lattices and their symmetries
3	Wed 09/11/2019	Exercises
4	Mon 09/16/2019	Crystal symmetry, point groups and space groups I
4	Wed 09/18/2019	Crystal symmetry, point groups and space groups II
5	Mon 09/23/2019	Saudi National Day
5	Wed 09/25/2019	Crystal symmetry, point groups and space groups III
6	Mon 09/30/2019	Session with Librarian (tentative)
6	Wed 10/02/2019	Discussion of topical projects I / Revisions
7	Mon 10/07/2019	Mid-term exam
7	Wed 10/09/2019	Reciprocal lattice I
8	Mon 10/14/2019	Reciprocal lattice II
8	Wed 10/16/2019	Diffraction of X-rays I
9	Mon 10/21/2019	Diffraction of X-rays II
9	Wed 10/23/2019	Diffraction of X-rays III
10	Mon 10/28/2019	Mid-semester break
10	Wed 10/30/2019	Discussion of topical projects II
11	Mon 11/04/2019	Diffraction of X-rays practical aspects I
11	Wed 11/06/2019	Diffraction of X-rays practical aspects II
12	Mon 11/11/2019	Neutron diffraction I
12	Wed 11/13/2019	Neutron diffraction II
13	Mon 11/18/2019	Electron diffraction I
13	Wed 11/20/2019	Electron diffraction II
14	Mon 11/25/2019	Electron diffraction III
14	Wed 11/27/2019	Advanced topics presentations
15	Mon 12/02/2019	Mock final exam
15	Wed 12/04/2019	Revisions
16	Mon 12/09/2019	Exams week

Note

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