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

Course Syllabus: Crystallography and Diffraction - MSE 301

Division	Physical Science and Engineering Division
Course Number	MSE 301
Course Title	Crystallography and Diffraction
Academic Semester	Spring
Academic Year	2016/2017
Semester Start Date	01/22/2017
Semester End Date	05/18/2017
Class Schedule (Days & Time)	04:00 PM - 5:30 PM on Mon & 02:30 PM - 04:00 PM on Wed

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Aram Amassian	aram.amassian@kaust.edu.sa	+966128081288	3232, 5, Al-Kindi (bldg. 5)	By appointment.
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	MSE301 ï Crystallography and Diffraction is one of the Core Courses of the MSE Program. In the Spring2017 semester, it will run from 22 January to 18 May, with two sessions per week, Monday and Wednesday. MSE301 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. Braggôs 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 (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	**30.00**% - Final exam **20.00**% - Presentation **30.00**% - Midterm exam **20.00**% - Homework /Assignments
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 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	Mon 01/23 & Wed 01/25	Mon 23 Jan: Discussion of syllabus and introduction to crystallography Wed 25 Jan: Materials background I
2	Mon 01/30 & Wed 02/30	Mon 30 Jan: Materials background II Wed 1 Feb: 1D and 2 D patterns, lattices and symmetries
3	Mon 02/06 & Wed 02/08	Mon 6 Feb: Bravais lattices and their symmetries I Wed 8 Feb: Bravais lattices and their symmetries II
4	Mon 02/13 & Wed 02/15	Mon 13 Feb: Crystal symmetry, point groups and space groups I Wed 15 Feb: Crystal symmetry, point groups and space groups II
5	Mon 02/20 & Wed 02/22	Mon 20 Feb: Crystal symmetry, point groups and space groups III Wed 22 Feb: Crystal symmetry, point groups and space groups IV
6	Mon 02/27 & Wed 03/01	Mon 27 Feb: Session with librarian (tentative) Wed 1 Mar: Discussion of topical projects I
7	Mon 03/06 & Wed 03/08	Mon 6 Mar: Mid-term exam Wed 8 Mar: Properties of crystals
8	Mon 03/13 & Wed 03/15	Mon 13 Mar: Reciprocal lattice I Wed 15 Mar: Reciprocal lattice II
9	Mon 03/20 & Wed 03/22	Mon 20 Mar: Discussion of topical projects II Wed 22 Mar: Diffraction of X-rays I
10	Mon 03/27 & Wed 03/29	Mon 27 Mar: Diffraction of X-rays II Wed 29 Mar: Electron diffraction I
11	Mon 04/03 & Wed 04/05	Mon 3 Apr: Spring Break Wed 5 Apr: Spring Break
12	Mon 04/10 & Wed 04/12	Mon 10 Apr: Electron diffraction II Wed 12 Apr: Electron diffraction III
13	Mon 04/17 & Wed 04/19	Mon 17 Apr: Neutron diffraction Wed 19 Apr: Discussion of topical project III
14	Mon 04/24 & Wed 04/26	Mon 24 Apr: Practical aspects of X-ray diffraction Wed 26 Apr: Student presentations I
15	Mon 05/01 & Wed 05/03	Mon 1 May: Student presentations II Wed 3 May: Student presentations III
16	Mon 05/08 & Wed 05/10	Mon 8 May: Revisions Wed 10 May: Revisions
17	Mon 05/15 & Wed 05/17	Mon 15 May: Final exams week Wed 17 May: Final exams week
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Note

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