ENGR 1053: Structures of Crystals and Diffraction

FALL, 2024

INSTRUCTOR: Dr. Shijing Luo

OFFICE: Room 522 (New Building)

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OFFICE HOURS: Wednesday & Friday: 13:00-17:00, or by appointment

LECTURES: Wednesday 8:15-11:00
Room 4-202

TEXTBOOK:

- M. De Graef and M.E. McHenry, "Structure of Materials", Cambridge University Press, 2nd edition (2012)
- Additional references and supplementary materials will be posted on Blackboard.

Reference Books

- C. Hammond, The Basics of Crystallography and Diffraction, Oxford University Press, 2nd edition (2000) and reprinted 2003. (Key Reference)
- Kelly and G.W. Groves, Crystallography and Crystal Defects, Addison esley (1970).
- Kelly, G.W. Groves and P. Kidd, Crystallography and Crystal Defects, John Wiley & Sons (2000).
- M.J. Buerger, Elementary Crystallography, Wiley (1963).
- B.D. Cullity, Elements of X-Ray Diffraction, Addison-Wesley (1978).
- B.D. Cullity and S.R. Stock, Elements of X-Ray Diffraction, 3rd Edition Prentice Hall (2001).
- K.J. Kurdzydlowski and B. Ralph, The Quantitative Description of the Microstructure of Materials, CRC (1995).
- D.M. Adams, Inorganic Solids, Wiley (1974).
- V. Randle, Microstructure Determination and its Applications, Inst. Of Materials, London (1992).
- V. Randle, The Role of Coincidence Site Lattice in Grain Boundary Engineering, Inst. Of Materials, London (1996).
- C.S. Barrett and T.B. Massalski, Structure of Metals, McGraw-Hill, 3rd ed. (1966).
- R. Tiley, Crystals and Crystal Structures, Wiley (2006).
- S.M. Allen and E.L. Thomas, "Structure of Materials", Wiley, 1999.

PREREQUISITE:

Materials Structure and Properties (Or equivalent, or consent of instructor)

DESCRIPTION:

This course is 3 credits.

Basic crystallography of materials; symmetry; point groups and space groups; tensor properties of crystals; diffraction methods in materials science; atomic packing and structures; glassy state, polycrystalline aggregates; grain boundaries and interfaces in materials; textures; multiphase materials; quantitative stereology and microstructural characterization.

COURSE OBJECTIVES:

This course aims to provide students with a comprehensive understanding of the principles of crystal structure, the techniques used to determine these structures, and the techniques used to determine these structures. This course will provide a foundation for further studies in materials science, chemistry, physics, or engineering, where knowledge of crystal structures is essential.

LEARNING OUTCOMES FOR THIS COURSE:

After the successful completion of this course, students should be able to:

1) List the four states of matter and different structural states of condensed phases.
2) Discuss examples of how structure in addition to the chemical composition of an engineered material affects properties and performance in applications.
3) Differentiate between long-range and short-range order as it relates to the description of the structure of materials.
4) Define the differences between non-crystalline and crystalline materials in terms of suitable descriptors.
5) List symmetry properties and use them to describe the structure of crystals.
6) List several basic descriptors suitable for discussion of the structure of materials.

GRADE DETERMINATION:

5%: participation (bonus)

30%: homework and in-class quizzes

30%: midterm exam

35%: final exam

EXAMS:

There will be two midterm exams and one final exam.

QUIZZES:

To be announced one week ahead.

GRADE Policy:

A: 90 – 100	B+: 80 – 84	B−: 73 – 75	C: 66 – 69	D: 60 – 62
A−: 85 – 89	B: 76 – 79	C+: 70 – 72	C−: 63 – 65	F: < 60

HOMEWORK:

To be assigned at the end of each lecture. Submission requirements (including due dates) for all assessments will be announced to students in class or on Blackboard.

ATTENDANCE:

Attendance will be taken at each class and will be evaluated in students' participation.

MAKE-UP POLICY:

Late assignments will be deducted 15% per day and will be not accepted after one week.

MATERIAL COVERED:

1. Crystal structure
   - Two-dimensional symmetry and lattices
   - Bravais lattices and crystal system
2. Crystal symmetry
   - Symmetry operations
   - Point groups
   - Space groups
3. Lattice directions and planes
   - Miller indices, Miller-Bravais indices
   - Zones axes
4. Reciprocal lattice
5. X-ray diffraction
   - Diffraction geometry
   - Diffraction intensities
   - Diffraction of polycrystal
6. Electron diffraction

Academic Integrity:

All students are expected to adhere to the standards of academic honesty. Any student engaged in cheating, plagiarism, or other acts of academic dishonesty would be subject to disciplinary action. Any student suspected of violating this obligation for any reason during the semester will be required to participate in the procedural process, initiated at the instructor level, as outlined in the University Guidelines on Academic Integrity. This may include but is not limited to the confiscation of the examination of any individual suspected of violating the University Policy.