Course number and name: MTSE 3010: Bonding and Structure

Credits and contact hours: 3 Credits. Office Hours: Wednesday 2 PM - 4 PM

Instructor’s or course coordinator’s name: Dr. Thomas Scharf

Text book, title, author, and year

  a. Other supplemental materials
     Structure and Bonding in Crystalline Materials
     By Gregory S. Rohrer, Cambridge University Press

Specific Course Information
  a. Brief description of the content of the course (catalog description)
     Amorphous and crystalline structures in metals, ceramics and polymers, point defects in crystals, structure determination by X-ray diffraction.
  b. Prerequisites or co-requisites
     MTSE 3000, 3001
  c. Indicate whether a required, elective, or selected elective course in the program
     Required

Specific goals for the course
  a. Specific outcomes of instruction

<table>
<thead>
<tr>
<th>Specific Course Learning Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Understand the differences in atomic bonding and crystal structures for all material classes.</td>
</tr>
<tr>
<td>2. Analyze material structure across multiple size and length scales.</td>
</tr>
<tr>
<td>3. Recognize how material bonding and structure determines material properties.</td>
</tr>
<tr>
<td>4. Understand the importance of crystallography and crystal symmetry and how it relates to materials structure.</td>
</tr>
<tr>
<td>5. Apply the concepts of x-ray diffraction as a materials characterization technique to determine crystal structures.</td>
</tr>
</tbody>
</table>

  b. Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes that are addressed by the course.
This course addresses ABET Student Outcome 7

**Brief list of topics to be covered**

I. Electronic and Atomic Structure and Bonding
   - Review of Simple Bonding Models
   - Periodic Trends & Bonding Force/Energy
   - Lennard-Jones Model
   - Born-Mayer-Huggins Model

II. Crystal Structure
   - Crystal Lattice & Unit Cells
   - Metallic Crystal Structures
   - Ceramic Crystal Structures
   - Interstitial Compounds

III. Crystallography
   - Introduction to Crystallography
   - 2-D & 3-D Bravais Lattices
   - Primitive and Basis Vectors in Crystal Structures
   - Basic Symmetry Operations
   - 2-D Point & Plane Groups
   - 3-D Point Groups
   - Neumann’s Law and Tensor Properties
   - 3-D Space Groups
   - 3-D Symmetry Elements in Crystalline Materials
   - Relationships between planes and directions

IV. X-ray Diffraction - XRD
   - Introduction to XRD & Indexing Crystal Systems
   - Structure Factors
   - XRD Intensity Calculations
   - Texture Determination and Pole Figures
   - Stereographic Projection and Texture/Anisotropy

V. Structure of Non-crystalline (amorphous) Solids
   - Introduction to non-crystalline materials
   - Bernal Model
   - Medium-range ordering
   - Radial distribution function