DEPARTMENT OF CHEMISTRY  
CHEM-GA 2400-001  
The Science of Materials  
Fall 2020  
PRELIMINARY SYLLABUS

This is a preliminary syllabus that is subject to change once course registrations are complete and the number of students registered is known, which will likely be on or about August 30, 2020. The course lectures will be held remotely at 08:00 (New York time) Tuesdays and Thursdays to accommodate students from NYU Shanghai and NYU Abu Dhabi, as well as to ensure the safety of all. We also will hold an office hour every Wednesday at 08:00 (New York time), primarily to accommodate NYUSH and NYUAD students. This operates on the presumption that NYUSH and NYUAD students will not have conflicts with other classes at this time. An additional office hour has been scheduled at 16:00 on each Thursday, but this is subject to change as we will attempt to accommodate the NYUNY students. This will be decided on the first day of the semester.

Please note that lectures and office hours will be held ZOOM. You will be invited to the ZOOM meetings by the CLASSES site. There is a unique ZOOM link for the Monday and Wednesday lectures. Likewise, each office hour has a unique ZOOM link as well. The lecture ZOOM link will be open to students at 07:45 each morning. You can use this time to talk with each other, ask me questions, organize your thoughts. For security reasons, you will be required to use a Passcode to join the ZOOM lectures and office hours. The Passcode is CONFIDENTIAL. If this is leaked outside the group of registered or auditing students, we will need to switch to a waiting room format, which I believe is less appealing.

Course Description

This is a comprehensive foundation course that addresses basic concepts of materials science that are useful for students interested in the structure and properties of materials, as well as enrolling in future courses in the materials field. The course is designed for graduate students and upper-level undergraduates in the disciplines of chemistry, chemical engineering, materials science, and physics. Topics include bonding forces, crystal structures, defects, X-ray diffraction, solid-state phase diagrams, crystallization mechanisms, diffusion in solids, and mechanical, and electrical properties. The spectrum of everyday materials is wide – metals, ceramics, polymers, liquid crystals, colloids, organic crystals – and this course will cover key basic concepts of materials science, many which unify these kinds of materials. These concepts, and the accompanying “language” of materials science are applicable in, and useful for, the sub-disciplines of materials chemistry, materials physics, and materials engineering.

First Class Day: Thursday, September 3  
Last Class Day: Thursday, December 10  
Course Web Site: See NYU CLASSES for course details  
Lectures: Tuesday and Thursday (TTh) 08:00 – 09:30  
Location: ZOOM (link provided by the CLASSES course site)  
Instructor: Michael D. Ward (MDI laboratories, Brown 554, mdw3@nyu.edu)  
Office Hours: Wednesday 08:00 - 09:00 (intended primarily for NYUSH and NYUAD students)  
           Thursday 16:00 – 17:00 (intended primarily for NYUNY students)
ZOOM (separate link for each office hour provided by the CLASSES course site; note the same link as the lecture)

**Textbook:** *Materials Science and Engineering: An Introduction*, 10th Edition (or equivalent; older editions are adequate); W. D. Callister, Jr. and D. G. Rethwisch, John Wiley & Sons, Inc. The Textbook should be viewed as a guide, as we occasionally will supplement with other books and scientific literature. Also note – some lecture topics will NOT appear in the order of the chapters in the book. This version is available in digital and hardcopy forms from the NYU Bookstore.


**Prerequisites:** Graduate students in Chemistry, Chemical Engineering, Materials Science, Physics, Math, Biomaterials, and related fields. Upper-level undergraduates can enroll with permission of undergraduate advisor and course instructor.

**Course Objectives**
Learn the scientific principles underlying the structure of materials, including everyday “stuff.” Topics include interatomic and intermolecular bonding, crystal structure, defects, and microstructure. Understand the importance of phase behavior and diffusion in crystallization and principles of structural characterization. Learn fundamental relationships between structure and materials properties, including mechanical and electrical properties. Develop an understanding of various types of materials and their structure, properties and applications.

**Exams:** NONE

**Problem Sets**
Problem sets will be available for download from the CLASSES course site on or before each Monday. The cover page of the problem set should be the first page of the assignment, with your name and student ID number clearly written in the space provided.

Completed problem sets must be uploaded to the CLASSES course site on the following Monday, prior to the beginning of the Monday lecture at 08:00. NO EXCEPTIONS. In cases of documented illness or family emergency, the missed problem set(s) will not be used in evaluating your grade, but no more than two problem sets will be waived. Questions about course material and problem sets must be addressed during office hours, not by Email.

Please note that Problem Sets constitute a substantial portion of the final grade. These and other projects are in lieu of exams. **Consequently, you are expected to complete your Problem Sets individually.** This does not preclude you from working with your fellow classmates to understand general concepts, however. Sometimes, even often, your peers are your best sounding boards.

**Journal Club assignment**
As graduate students or advanced undergraduates you will find critical reading of the literature to be an essential component of your professional development. This exercise will require that you serve as a lead reviewer for a research article of your choice in the area of materials science, which could be aligned with your subdiscipline (e.g., materials chemistry or materials physics). Your review will consist of a written
report that critically assesses the article. The instructor provide a list of journals from which the articles can be selected, as well as a template for your review that will resemble a typical journal review form. In addition, you will be asked to present a 10 minute summary of your review to the class. Each student of the class will serve as secondary reviewers, required to read all journal articles selected and provide comments on a Qualtrix survey provided by the instructor. This exercise will be a test for consistency of the reviews. Consequently, you will be using a process that is central to the peer review system as well as proposal reviews at funding agencies. More details will be provided two weeks prior to the assignment due date, which will sometime mid-semester. We will schedule a meeting time outside of the scheduled class time for the presentations.

**Capstone Project**

A capstone assignment will be due **Wednesday, November 25**. The assignment requires that you choose a COMPLEX machine or consumer product, and break it down into its individual components and materials. Each material must be described thoroughly, including the elemental composition, components, microstructure, crystallinity, methods of analysis that would be used to characterize each material, and representative characterization data for each component. The findings should be reported in the form of a YouTube video or a PowerPoint file, which you will present to the class at the end of the year. You will work in pairs, although the size of the group and the length of presentation may change depending on course enrollment. We will schedule a meeting time outside the scheduled class time for the presentation.

**Grading:**

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<th>Percentage</th>
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<tbody>
<tr>
<td>Problem Sets</td>
<td>40%</td>
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<tr>
<td>Journal Club Report (written)</td>
<td>20%</td>
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<tr>
<td>Journal Club Report (oral)</td>
<td>10%</td>
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<tr>
<td>Capstone Project</td>
<td>30%</td>
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**Schedule of Topics (may be subject to slight changes)**

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<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Topic</th>
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<tbody>
<tr>
<td>1:</td>
<td>September 3 (Th)</td>
<td>Course introduction, Classes of Materials</td>
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<td>2:</td>
<td>September 7</td>
<td>Crystal Structures</td>
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<td>3:</td>
<td>September 14</td>
<td>Directions, Planes, Diffraction</td>
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<td>4:</td>
<td>September 21</td>
<td>Diffraction Analysis</td>
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<td>5:</td>
<td>September 28</td>
<td>Bonding and Forces in Materials</td>
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<td>6:</td>
<td>October 5</td>
<td>Metals vs. Ceramics, Defects</td>
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<td>7:</td>
<td>October 12</td>
<td>Dislocations</td>
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<td>8:</td>
<td>October 19</td>
<td>Mechanical Properties</td>
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<td>9:</td>
<td>October 26</td>
<td>Phase Diagrams; thermodynamic concepts</td>
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<td>10:</td>
<td>November 2</td>
<td>Phase Transitions, Crystallization</td>
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<td>11:</td>
<td>November 9</td>
<td>Kinetics; TTT diagrams</td>
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<td>12:</td>
<td>November 16</td>
<td>Diffusion</td>
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<td>12:</td>
<td>November 23</td>
<td>Soft Materials: Advanced Polymers and Colloids</td>
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<td>12:</td>
<td>November 26,27</td>
<td>Thanksgiving Holiday (Thu, Fri)</td>
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<td>13:</td>
<td>November 30</td>
<td>Electrical Properties</td>
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<td>14:</td>
<td>December 7</td>
<td>Electrical Devices</td>
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<td>15:</td>
<td>December 10</td>
<td>Last Day of Class</td>
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**Academic Dishonesty**

Academic dishonesty is incompatible with the practice of science or any profession. If evidence of dishonesty is found, the policy of the College of Arts and Sciences or the Graduate School of Arts and Sciences, as appropriate, will be followed. This includes any form of plagiarism, copying, collusion or
cheating during an examination of any kind. All such cases are reported to the Director of Undergraduate Studies or the Director of Graduate Studies. University policy states: “Students who engage in such behavior will be subject to review and the possible imposition of penalties in accordance with the standards, practices, and procedures of NYU and its colleges and schools. Violations may result in failure on a particular assignment, failure in a course, suspension or expulsion from the University, or other penalties.” If suspended or expelled from the University, a notation will be made on your record as to the cause. A notation is very SERIOUS, as it could translate to a barring of entry to a professional school of any kind, e.g. medical school, graduate school and, possibly, difficulty in landing a job.

Excellent students such as you are probably offended at even the mention of cheating. But temptation can arise even among the accomplished. If you are having difficulties, talk to your instructor immediately. Read and understand the above before you consider compromising your integrity - and your future.

Disabilities
Students with Disabilities are encouraged to contact the instructor for a confidential discussion of their individual needs for academic accommodation. It is the policy of NYU to provide flexible and individualized accommodation to students with documented disabilities that may affect their ability to fully participate in course activities or to meet course requirements. To receive accommodation services, students must be registered with the Moses Center for Students with Disabilities (mosescsd@nyu.edu) as soon as possible. Any student who needs a reasonable accommodation based on a qualified disability is required to register with the Moses Center for assistance. The Moses Center will send the course instructors official notification of your accommodation needs. Please make an appointment with the instructor to discuss the accommodations and how course requirements and activities may impact your ability to fully participate.

Classroom (ZOOM) Etiquette
While some of you may have experienced remote learning, it may be a new experience for you. It certainly is for your instructor. This requires that we all be patient and understanding, as undoubtedly there will be technical glitches, as well as changes in how we configure the course components to optimize learning. Courteous and civil behavior is expected and anything apart from that will not be condoned. A university exists for the free but critical exploration of ideas and developing understanding of a myriad of topics. This can only be achieved through respect for the institution itself and among the scholars that comprise it. Anything other than polite (which does not exclude passionate or spirited debate) behavior is inexcusable. The fundamental rule is simple: Be considerate of others.

ZOOM meeting tips
- You will have audio and video access. Please leave your video on to create a semblance of a “real-feel” classroom.
- But…remember that the instructor and class can see you if your video is on. If you would prefer not to show your surrounding to the class, you can use a virtual background. Default options are available in ZOOM, but you can create one easily as well.
- Please mute your audio during the lectures.
- Remote classes on ZOOM can be clumsy, subject to time delays in questions and answers, which can lead to us talking over each other. In order to minimize this, I ask that you post your questions to the ZOOM chat. I will stop at regular 15-minute intervals to answer these chat questions or to have a conversation. You can send your questions to the entire class, or anonymously to your instructor only.
- Your instructor reserves the right to call on you for input or to answer questions, however.
- On occasion, your instructor may send you, as teams, to breakout rooms to work out a problem. Be prepared to work. Have calculators and your textbook handy.
- Avoid private chats. They will distract you.
- I will be using a combination of powerpoint slides from a laptop and a whiteboard from an iPad. Please be prepared to write notes from the material on the whiteboard. I will make the powerpoint slides available on the CLASSES course site.
- Avoid eating during the lecture. Treat the class as you would if it was in-person.
- Gum and (need I say this) tobacco chewing is prohibited.
- Please silence cell phones and incoming message and notification alerts to your ZOOM device before class.
- Although your instructor will know from the participant list if you are attending, please inform your instructor if you will not be attending class.
- If you need to leave the ZOOM lecture, please send a chat, to your instructor only, so he knows you have left the meeting.
- Office hours will be more free flowing, with conversations directly through audio.
- I will be sending you a survey occasionally for candid input about how the configuration of the ZOOM lectures can be improved. Despite the fact that we all have been ZOOMing for some time now, this is still a work in progress.