

## APPL 462-001

# Engineering Materials: Properties, Selection and Design

Fall 2022 (updated 8/15/2022)

### Course Essentials

➤ DESCRIPTION AND OUTCOMES	
<b>Course Description</b>	This course will cover both fundamental and applied aspects of modern materials science. We will discuss how to select materials based on their properties and how they can be processed into products that you encounter in everyday life. A strong focus will be on the relationship between processing, structure (development), and properties of solid materials, such as metals, ceramics, and polymers.
<b>Connecting Materials with your major</b>	The principles and technology that you will learn will let you better understand the properties of engineering materials and be able to select the best materials for designing a product. However, that is not the sole objective of this class. An important goal of this course is to help you develop an entrepreneurial mindset by connecting materials science and engineering with your major, so you may recognize opportunities by applying the materials and techniques to your future study and career.
<b>Learning outcomes - For the course</b>	By the end of this course, students should be able to: <ul style="list-style-type: none"> <li>• describe different types of materials used by engineers</li> <li>• define crystalline structures of inorganic materials and typical polymer structures</li> <li>• identify different types of crystal defects</li> <li>• distinguish between steady-state and nonsteady-state diffusion</li> <li>• interpret phase diagrams and predict phase transformations</li> <li>• explain the influence of structure and defects on mechanical properties</li> <li>• tell the relationship between processing and properties of materials</li> <li>• choose suitable material characterization techniques</li> <li>• recognize the typical electrical, magnetic, optical, and thermal properties of materials</li> <li>• select suitable materials for the design of certain products</li> </ul>
<b>For the IDEAs in Action General Education</b>	These are the learning outcomes that are expected of students after completing a course. <ul style="list-style-type: none"> <li>• Demonstrate the ability to use scientific knowledge, logic, and imagination to construct and justify scientific claims about naturally occurring phenomena, including validation through rigorous empirical testing.</li> <li>• Analyze and apply processes of scientific inquiry as dictated by the phenomena and questions at hand. These include generating and testing hypotheses or theories pertaining to the natural world; using logic and creativity to design investigations to test these hypotheses; collecting and interpreting data about the natural world; making inferences that respect measurement error; building and justifying arguments and explanations; communicating and defending conclusions; revising arguments and conclusions based on new evidence and/or feedback from peers; and synthesizing new knowledge into broader scientific understanding.</li> </ul>

## For Engineering Student




- Evaluate science-related claims and information from popular and/or peer-reviewed sources by examining the relationship between the evidence, arguments, and conclusions presented and by assessing consistency with existing knowledge from valid and reliable scientific sources.

By the end of this course, students will gain experience in the following engineering student outcomes:


- integrate information from many sources to gain insight
- identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- communicate effectively with a range of audiences
- develop and conduct appropriate experimentation, analyze, and interpret data, and use engineering judgement to draw conclusions

## ➤ INSTRUCTOR

Dr. Zijie Yan

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## ➤ LOGISTICS

 **Class meeting times**  
 MW: 12:20 PM-01:35 PM  
 08/15/2022-12/09/2022

 **Class meeting location**  
 Genome Sciences Bldg - Rm G010

 **Office Hours**  
 After class, or by appointment

### Required Texts & Software

- Fundamentals of Materials Science and Engineering: An Integrated Approach, 6e, William D. Callister and David G. Rethwisch, Wiley (2021)
- Book options from [Wiley](#) or from UNC bookstore (with a WileyPLUS access code)
  - 9781119764816 - WileyPLUS one term access (\$62.50 net to the bookstore)
  - 9781119750499 - WileyPLUS one term access + loose leaf text (\$94.50 net to the bookstore)
- **Note:** we will use WileyPLUS for assignments and activities, which requires an access code to register. When you click on the course in Canvas, you will be prompted to either enter an access code you've already purchased or buy one right then.
- Course management system:
  - Canvas: <https://uncch.instructure.com/>

### ➤ Pre-requisites

- CHEM 102; or PHYS 116 or PHYS 118.

## ➤ COURSE TOPICS

1. Introduction
  - Classification of Materials
  - Interatomic Bonding in Materials
2. Structures of Engineering Materials
  - Metal Structures
  - Ceramic Structures

- Polymer Structures
- Imperfections in Solids
- 3. Properties of Engineering Materials
  - Mechanical Properties
  - Electrical Properties
  - Magnetic Properties
  - Optical Properties
  - Thermal Properties
- 4. Material Characterization Techniques
- 5. Design and Processing of Materials
  - Fabrication and Processing of Materials
  - Heat Treatment: Diffusion
  - Dislocations and Strengthening Mechanisms
  - Phase Diagrams and Transformations
- 6. Selection of Engineering Materials
  - Properties, Durability, and Costs
  - Environmental and Societal Issues

## ➤ COURSE SCHEDULE

For week-by-week schedule, see announcements on Canvas

## Grade scale and grading rubric

### ➤ YOUR COURSE GRADE

40%: Homework	Most homework will be assigned online via Canvas, and some need to be done on paper.
30%: Activities, Projects, and Presentations	There will be in-class activities regularly; projects are expected using CHANL and /or BeAM; presentations will be required to introduce new materials and summarize the activities and projects.
10%: Mid-term exam	There will be one mid-term exam.
20%: Final Exam	The final exam is comprehensive that covers all chapters. All exams are open book.
100%: total	

### ➤ GRADE INTERPRETATION

Your final course grade will be determined from a standard scale:

A	93+
A-	90.0 - 92.9
B+	87.0 - 89.9
B	83.0 - 86.9
B-	80.0 - 82.9
C+	77 - 79.9
C	73 - 76.9
C-	70 - 72.9

D+	67 - 69.9
D	60 - 66.9
F	<60

## ➤ MAJOR COURSE DUE DATES

Mid-term exam	Oct. 10 (any change will be announced ahead)
Final Exam	Final exam week (Dec. 2-9)

## Academic Policies

### ➤ POLICIES

#### Course Expectations and policies

All students are expected to

- Come to every scheduled class and let the professor know ahead of time if you cannot attend.
- Turn in assignments on time; if an assignment is up to 24 hours late, there is a 25% deduction, and if an assignment is beyond 24 hours late, you will get a zero. If you need an extension, you must ask at least 24 hours before the time that the assignment is due (you can avoid a grade deduction this way).

#### Syllabus Changes

The professor reserves the right to make changes to the syllabus including project due dates and test dates. These changes will be announced as early as possible.

#### Attendance Policy

**University Policy:** As stated in the University's [Class Attendance Policy](#), no right or privilege exists that permits a student to be absent from any class meetings, except for these University Approved Absences:

1. Authorized University activities
2. Disability / religious observance / pregnancy, as required by law and approved by [Accessibility Resources and Service](#) and / or the [Equal Opportunity and Compliance Office](#) (EOC)
3. Significant health condition and / or personal / family emergency as approved by the [Office of the Dean of Students](#), [Gender Violence Service Coordinators](#), and / or the [Equal Opportunity and Compliance Office](#) (EOC).

**Class Policy:** Instructors may work with students to meet attendance needs that do not fall within University approved absences. For situations when an absence is not University approved (e.g., a job interview or club activity), instructors determine their own approach to missed classes and make-up assessment and assignments.

**University Approved Absence Office (UAAO):** The [UAAO](#) website provides information and FAQs for students and faculty related to University Approved Absences.

**Note:** Instructors have the authority to make academic adjustments without official notice from the UAAO. In other words, it is not required for instructors to receive a University Approved Absence notification in order to work with a student. In fact, instructors are encouraged to work directly with students when possible.

#### Honor Code

All students are expected to follow the guidelines of the UNC Honor Code. In particular, students are expected to refrain from “lying, cheating, or stealing” in the academic context. If you are unsure about which actions violate the Honor Code, please see me or consult [studentconduct.unc.edu](https://studentconduct.unc.edu).

### **Optional Mask Use Statement**

UNC-Chapel Hill is committed to the well-being of our community – not just physically, but emotionally. The indoor mask requirement was lifted for most of campus on March 7, 2022. If you feel more comfortable wearing a mask, you are free to do so. There are many reasons why a person may decide to continue to wear a mask, and we respect that choice.

### **Acceptable Use Policy**

By attending the University of North Carolina at Chapel Hill, you agree to abide by the University of North Carolina at Chapel Hill policies related to the acceptable use of IT systems and services. The Acceptable Use Policy (AUP) sets the expectation that you will use the University’s technology resources responsibly, consistent with the University’s mission. In the context of a class, it’s quite likely you will participate in online activities that could include personal information about you or your peers, and the AUP addresses your obligations to protect the privacy of class participants. In addition, the AUP addresses matters of others’ intellectual property, including copyright. These are only a couple of typical examples, so you should consult the full [Information Technology Acceptable Use Policy](#), which covers topics related to using digital resources, such as privacy, confidentiality, and intellectual property.

Additionally, consult the University website “[Safe Computing at UNC](#)” for information about the data security policies, updates, and tips on keeping your identity, information, and devices safe.

## Academic Resources

### **➤ RESOURCES**

#### **Accessibility Resources and Service**

The University of North Carolina at Chapel Hill facilitates the implementation of reasonable accommodations, including resources and services, for students with disabilities, including mental health disorders, chronic medical conditions, a temporary disability or pregnancy complications resulting in barriers to fully accessing University courses, programs and activities.

Accommodations are determined through the Office of Accessibility Resources and Service (ARS) for individuals with documented qualifying disabilities in accordance with applicable state and federal laws. See the ARS Website for contact information: <https://ars.unc.edu> or email [ars@unc.edu](mailto:ars@unc.edu).

#### **Counseling and Psychological Services**

UNC-Chapel Hill is strongly committed to addressing the mental health needs of a diverse student body. The [Heels Care Network](#) website is a place to access the many mental resources at Carolina. CAPS is the primary mental health provider for students, offering timely access to consultation and connection to clinically appropriate services. Go to their website <https://caps.unc.edu/> or visit their facilities on the third floor of the Campus Health building for an initial evaluation to learn more. Students can also call CAPS 24/7 at 919-966-3658 for immediate assistance.

#### **Title IX Resources**

Any student who is impacted by discrimination, harassment, interpersonal (relationship) violence, sexual violence, sexual exploitation, or stalking is encouraged to seek resources on campus or in the community. Reports can be made online to the EOC at <https://eoc.unc.edu/report-an-incident/>. Please contact the University’s Title IX Coordinator (Elizabeth Hall, [titleixcoordinator@unc.edu](mailto:titleixcoordinator@unc.edu)), Report and Response

Coordinators in the Equal Opportunity and Compliance Office ([reportandresponse@unc.edu](mailto:reportandresponse@unc.edu)), Counseling and Psychological Services (confidential), or the Gender Violence Services Coordinators ([gvsc@unc.edu](mailto:gvsc@unc.edu); confidential) to discuss your specific needs. Additional resources are available at [safe.unc.edu](http://safe.unc.edu).

### **Policy on Non-Discrimination**

The University is committed to providing an inclusive and welcoming environment for all members of our community and to ensuring that educational and employment decisions are based on individuals' abilities and qualifications. Consistent with this principle and applicable laws, the University's [Policy Statement on Non-Discrimination](#) offers access to its educational programs and activities as well as employment terms and conditions without respect to race, color, gender, national origin, age, religion, genetic information, disability, veteran's status, sexual orientation, gender identity or gender expression. Such a policy ensures that only relevant factors are considered and that equitable and consistent standards of conduct and performance are applied.

If you are experiencing harassment or discrimination, you can seek assistance and file a report through the Report and Response Coordinators (see contact info at [safe.unc.edu](http://safe.unc.edu)) or the [Equal Opportunity and Compliance Office](#), or online to the EOC at <https://eoc.unc.edu/report-an-incident/>.

### **Diversity Statement**

I value the perspectives of individuals from all backgrounds reflecting the diversity of our students. I broadly define diversity to include race, gender identity, national origin, ethnicity, religion, social class, age, sexual orientation, political background, and physical and learning ability. I strive to make this classroom an inclusive space for all students. Please let me know if there is anything I can do to improve. I appreciate suggestions.

### **Undergraduate Testing Center**

The College of Arts and Sciences provides a secure, proctored environment in which exams can be taken. The center works with instructors to proctor exams for their undergraduate students who are not registered with ARS and who do not need testing accommodations as provided by ARS. In other words, the Center provides a proctored testing environment for students who are unable to take an exam at the normally scheduled time (with pre-arrangement by your instructor). For more information, visit <http://testingcenter.web.unc.edu/>.

### **Learning Center**

Want to get the most out of this course or others this semester? Visit UNC's Learning Center at <http://learningcenter.unc.edu> to make an appointment or register for an event. Their free, popular programs will help you optimize your academic performance. Try academic coaching, peer tutoring, STEM support, ADHD/LD services, workshops and study camps, or review tips and tools available on the website.

### **Writing Center**

For free feedback on any course writing projects, check out UNC's Writing Center. Writing Center coaches can assist with any writing project, including multimedia projects and application essays, at any stage of the writing process. You don't even need a draft to come visit. To schedule a 45-minute appointment, review quick tips, or request written feedback online, visit <http://writingcenter.unc.edu>.

### **Grade Appeal Process**

If you feel you have been awarded an incorrect grade, please discuss with me. If we cannot resolve the issue, you may talk to our departmental director of undergraduate studies or appeal the grade through a formal university process based on arithmetic/clerical error, arbitrariness, discrimination, harassment, or personal malice. To learn more, go to the [Academic Advising Program](#) website.