APPLIED PHYSICAL SCIENCES

THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

APPL 490-002

Engineering Materials: Properties, Selection, and Design

Fall, 2020

Introduction	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. Topics include crystal structures, imperfections, diffusion, mechanical properties, deformation mechanisms, phase diagram, phase transformations, material characterization techniques, and electrical, magnetic, optical, and thermal properties of materials.
Methods	This class will use the HyFlex Instruction with both face-to-face and remote teaching sessions. The primary teaching mode for lectures and student presentations will be remote, and the primary mode for demonstrations, activities, projects, and other events will be face-to-face. The selection of teaching mode is subject to change upon the COVID-19 situation on campus. The default teaching method will be through the Zoom meeting. A class in the Fetzer Hall will be announced at least one day ahead, and the class will still be available on Zoom. All classes will be recorded, and links to the videos will be released on Sakai. We will use mixed teaching styles including regular and flipped classrooms. • In a regular classroom, the instructor will give lectures on certain topics. Multiple-choice questions may be given after the lectures. • In a flipped classroom, you need to watch a lecture video, either from the WileyPLUS resources or recorded by the instructor before the class. You will then work on a set of problems in the class, either online (WileyPlus) or on paper, and collaborations and discussions are encouraged. Your answers will be collected and graded. Demonstrations and class projects will be a critical part of this course and involve the use of the UNC makerspace (BeAM) and the Chapel Hill Analytical and Nanofabrication Laboratory (CHANL) when possible. You also need to present recent developments in materials science and engineering, ideally related to your major.
Results	*By the end of this course, students should be able to:* • Know different types of materials used by engineers • Define crystalline structures of inorganic materials and know typical polymer structures • Understand different types of crystal defects • Distinguish between steady-state and nonsteady-state diffusion • Interpret phase diagrams and predict phase transformations • Understand the influence of structure and defects on mechanical properties

	• Tell the relationship between processing and properties of materials • Know how to choose material characterization techniques • Recognize the typical electrical, magnetic, optical, and thermal properties of materials • Select suitable materials for the design of certain products
Discussion	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.
Engineering Student Outcomes	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.

Class Essentials

➢ CONTACT INFORMATION

Dr. Zijie Yan

Office Location
Caudill 159

Email
zijieyan@unc.edu

Phone
9198435056

Teaching assistants

(not applicable)

➢ LOGISTICS

Class meeting times
Monday/Wednesday 1:20PM-2:35PM

Class meeting location
Remote: https://unc.zoom.us/j/94347155283
Face-to-face: Fetzer Hall - Rm 0109

Office Hours
After class, or by appointment

Required Texts & Software

- Fundamentals of Materials Science and Engineering: An Integrated Approach, 5th Edition, William D. Callister and David G. Rethwisch, Wiley (2018) ISBN: 978-1-119-17550-6
- We will use WileyPLUS, please register following the course flyer on Sakai.
  - Briefly, visit www.wileyplus.com/go/login, and use the Course Section ID A51512
- Online resources:
  - WileyPlus: Assignments and supplementary online resources

- Sakai: Lecture slides and additional course materials.
- Textbook available from WileyPLUS during registration.
  - 6 month access to WileyPLUS + eTextbook $79
  - 6 month access to WileyPLUS + print book rental $99

Pre-requisites

- None

Course content

Course Topics

1. Introduction
2. Structures of Metals and Ceramics
3. Polymer Structures
4. Imperfections in Solids
5. Diffusion
6. Mechanical Properties
7. Phase Diagrams and Transformations
8. Synthesis, Fabrication, and Processing of Materials
9. Electrical, Magnetic, Optical, and Thermal Properties of Materials
10. Material Characterization Techniques

Course Schedule

For week-by-week schedule, see link on Sakai

To help you succeed

Course Expectations and Policies

All students are expected to

- Come to every scheduled class or Zoom session and let me 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).

Student Resources

SEE, SAY, DO SOMETHING	ACCESSIBILITY RESOURCES
We're happy you are here and eager to learn. Despite our best intentions to follow a plan, life may throw us a curve ball. If you or someone you know is experiencing some distress or you are concerned about the well-being of a student, please report it here: https://deanofstudents.unc.edu/carereport. It is important to support one another. If you see something, say, and do something.	UNC-CH provides accommodations for any students with documented disabilities. If you have a disability and believe you require accommodations, please contact the Department of Accessibility Resources at http://accessibility.unc.edu. Please contact me early in the semester so we can make any necessary arrangements and discuss the learning checks.

Assignments & Evaluation

➢ Your Course Grade

40%: Homework	Most homework will be assigned online using WileyPlus, and some need to be done on paper.
25%: Projects and Presentations	Projects are expected using BeAM and/or CHANL, and presentations will be required to introduce new materials and summarize the projects.
35%: Quizzes and Final Exam	There will be two quizzes and one final exam. Each quiz covers 3-4 chapters. The final exam is comprehensive that covers all chapters.
100%: total	

➢ Grade Interpretation & Honor Code

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

ACADEMIC HONESTY

There will be clear communication if assignments are individual or group. For individual assignments, while I encourage collaboration, it is a violation of the honor code if a student duplicates work or obtains solutions from another student and submits it on their own. Please reference the honor code: http://honor.unc.edu.

➢ Major Course Due Dates

Final Exam	November (TBD)

I reserve to right to make changes to the syllabus, including the teaching methods and weights and components in the course grade when unforeseen circumstances occur. These changes will be announced as early as possible so that students can adjust their schedules.

Updated 8/8/2020