

# ENGR 0022 - Materials Structures and Properties

## Course Syllabus

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### Catalog Description

An introduction to the principles of materials science. Topics include: electronic (atomic) structures of materials, crystal (lattice) structures, crystallography, microstructure (various defects), diffusion, phase diagram, phase transformation, mechanical properties of metal and alloys, ceramics (structures and properties), polymers (structures and properties), composites (structures and properties), corrosion, electrical properties, thermal properties, magnetic properties and optical properties. Prerequisites: MATH 0230 and PHYS 0174. 3 credit hours.

### Instructor

Prof. Grace Chan                      grace.chan@scu.edu.cn

### Textbook

*Materials Science and Engineering: An Introduction*, 9th Edition, by William D Callister.  
(published by McGraw Hill).

We will cover approximately one or two chapters per week. Textbook reading assignments will be posted to the class website. Read the assigned chapter BEFORE class.

### Software

We will use a powerful software tool, Matlab, to perform calculations and draw graphs. Matlab is installed on the class computers, and you will also need a copy for your own computer.

You will also use Microsoft Word to write up your assignments, and Microsoft Excel to draw scientific curves. Learn how to use the equation editor in Word and how to format documents, and how to draw engineering data curves.

### Course Goals

- To develop a general view of the field of materials science and engineering
- To gain knowledge of materials structures, properties and the relationships between them

- To understand the principles of materials design
- To gain proficiency in communication through written and oral reports
- To practice solving problems through teamwork
- To be familiar with the library resources for acquiring information of Materials Science and Engineering

## Topical Coverage

Week	Topic	Chapter
1	Introduction and FCC-HCP-BCC structures	1, 2
2	Crystallography	3
3	Crystallography (Studio/Lab Prac)	3
4	Microstructure: Defects	4
5	Microstructure: Dislocation	4, 7
6	Diffusion	5
7	Phase Diagram	9
8	Phase Transformation	10
9	Mechanical Properties	6, 7
10	Mechanical Properties	7, 8
11	Group Presentation: Structural Materials in Service	In relation to Chap 8
12	Ceramics Polymers	12, 13 14, 15
13	Composites Corrosion	16 17
14	Physical Properties	18
15	Group Presentation: Functional Materials	In relation to 19-21

## Class Format

Introduction to Materials Structures-Properties will be taught using a combined lecture/studio format. Each class will be run with a lecture (30-40 minute) to review material from the text and introduce new concepts. During the lecture,

problems/questions will be given, and you will work in small groups (3-4 students) to address the problems and questions by applying these concepts.

There are three types of weekly assignments: studio problems, homework problems, and group presentations. Studio problems are easy to moderately difficult, and will require only a short write-up. Studio problems are solved as a team. Group presentations will be prepared as a team and require a good team spirit. Homework problems will require considerable thought and effort outside of class.

**It is imperative that you come to class prepared.** This will generally involve reading one or more chapters of the textbook, viewing tutorial videos, thinking, engaging with fellow students, and performing preliminary calculations. This is a three credit hour class, which means you should expect to devote at least 9 to 12 hours of effort outside the scheduled class time every week.

## Studio Assignments

In each class, you will be assigned a number of studio problems. You will work on and complete these problems as a team during the class period; your team will demonstrate the solution to the instructor or TA before the end of class. The problems will be graded as either satisfactory or unsatisfactory; if they are unsatisfactory you must redo them and demonstrate them the following week.

## Group Presentations

4-6 students of each group jointly deliver a present, follow these guidelines:

- Identify an application of a structure material
- Discuss its engineering working conditions
- Identify its most likely failure
- Discuss the mechanisms of the failure
- Discuss the strategies to minimise the failure
- Future materials for the same application and Summary
- Timing

Your presentation should take no more than twelve minutes. Three minutes will be allotted for questions and discussion following your presentation.

Be prepared in case of technology breakdown (e.g., use the whiteboard if the computer or projector fails).

Both the instructors and your fellow students will evaluate presentations.

## Homework

Throughout the semester, homework problems will also be assigned every week. These are to be solved and turned in by Friday at 5:00pm the following week. You may work with other people on homework, but all write-ups must be individual efforts. Homework will be graded on a 0-100 point scale. Late homework will not be accepted.

All homework will be submitted electronically via the SCU email system.

Please adhere to these homework guidelines:

- Your assignment must be typeset using Word. Handwritten assignments will not be accepted.
- Put your name, ID number, and class section at the top of the first page.
- List the names of other people you've worked with on the assignment.
- All work must be shown for each solution to receive full credit. Present your solution in a logical fashion, showing and explaining all steps in detail.
- Adherence to form is an important part of this course. This includes proper English grammar, spelling, and word usage. Your computer has a spell checker, use it!
- A significant amount of the homework points is associated with obtaining the correct answer. This includes getting the correct quantity, **number of significant digits**, sign, and **unit**. Pay attention to all of these, they are important!

All of the homework scores will be used in your grade computation. Unless otherwise indicated, you can work with your fellow students in the class, but you must submit a distinct and independent write-up to receive credit.

If you're sick, or have a compelling emergency that prevents you from turning in the homework on time, email Prof. Chan.

If you believe an error has been made in the grading of an assignment, bring it to the attention of a TA or Prof. Chan within ONE WEEK of its return.

## Exams and Grading

There will be a midterm exam on or around November 15, and a comprehensive final examination at the end of the semester. The test and exam are CLOSED BOOK, CLOSED NOTES, CLOSED COMPUTER. You may bring one A4 page of notes (both sides). You will also find a calculator and a straightedge helpful.

Your grade will be based on the test (20%), homework (30%), final examination (20%), satisfactory completion of all studio assignments (10%) and two group participations (10%).

The instructor's role is to guide you in learning how to define, solve, and present materials science and engineering problems. You will not be judged on your ability to

recite memorized information, but on how well you make use of information and methods we cover in class. This should already be one of your primary educational goals in coming to university. The key to your success in this class is active participation.

## **Office Hours**

If you don't understand something, and talking to your classmates doesn't help, then you should be seeking help from one of the instructors.

Office hours are times we have specifically set aside to be available to students. During office hours, you can come to our office; you don't need an appointment. We are also available at other times; please email to schedule a time. Current office hours will be posted on the class website.

## **Plagiarism and Academic Misconduct**

Collaboration on studio problems and homework assignments is permitted and encouraged. Studio assignments are to be done as a team, with a single solution and write-up. Your homework write-ups will be individually written and represent your independent efforts.

Plagiarism, copying, and any other form of academic misconduct or dishonesty will not be tolerated. Cite all references, including books, technical reports, and web sites you have used. You may discuss the homework with other people currently taking this class, the instructors, and teaching assistants.

Examples of disallowed sources include websites that offer homework help; course documents from previous semesters; people or agencies that do your work for you.

You are not to share materials distributed in class with people outside the University. Uploading of course materials, including homeworks, handouts, homework and test solutions, etc. to the web is prohibited.

To reiterate: use of homework or test solutions from previous semesters or the web is not allowed. Getting homework help from the instructors and fellow students in the class is ok; looking up things on the Google, Baidu, and the Wikipedia is ok; getting help from websites offering homework help and problem solutions is NOT ok.

If you have any questions about referencing material, or the boundaries of acceptable collaboration, please talk to Prof. Chan.

## **Class Participation**

As members of an academic community, all students are expected to actively participate in and contribute to class discussions. You are expected to engage with the class during the lecture/studio time, and to be prepared to think and answer questions on your feet.

There is no penalty for not knowing the answer to a question, but you need to be able to "think out loud" and demonstrate the procedure you will follow to arrive at a solution. So, if you're asked a question in class, be prepared to figure out the answer.

## **Other Useful Information**

Although there are no formal prerequisites for this class, you are expected to know how, or learn how, to do the following:

- Use an internet browser to find things on the web.
- Use Matlab to evaluate numerical results, make graphs, and do multistep calculations.
- Use Word to write up and print your assignments.
- Use Excel to draw scientific curves
- Open, read, and print Acrobat pdf files.
- Find the logarithm of a number and understand what it is.
- Be proficient in basic pre-calculus mathematics, including plane geometry, trigonometry, algebra, and solution of simultaneous equations.