ENGR 0022: Material Structure and Properties

Course Syllabus – spring 2026

Catalog Description

ENGR 0022: Material Structure and Properties is an undergraduate course for students with materials science and engineering major. Intended for second-year students, this 3-credit course aims to convey the basic and comprehensive knowledge of materials science and engineering covering different types of materials, including metals, semiconductors, ceramics, polymers, composites, and etc. From learning this course, students will form the concept that "structure determines properties",and be equipped with the ability to explain macroscopic behaviors as based on the microscopic foundation and morphological characteristics of the corresponding materials. Process calculations will also weigh in to explain the working principles, physical phenomena, and failure mechanisms of materials. In the end, students are expected to develop capability of materials-by-design given specific optical, electrical, and magnetic property schemes upon the acquainted principle knowledge.

Course Instructor

Dr. Jue Gong, jue.gong@scupi.cn

Office hours: Thursday 10:00 am – 12:00 pm; Friday 10:00 am-12:00 pm, 02:30 pm – 04:30 pm, or by appointment.

Office

Room N526, SCUPI New Building

Contact information:

Email: jue.gong@scupi.cn

QQ: 181993588 (please indicate your name, course, and section)

Prerequisites

Math 0230 – Analytic Geometry and Calculus 2

PHYS 0174 – Physics for Science and Engineering 1

CHEM 0960 – General Chemistry for Engineers 1

Course Objectives

The course aims to let students gain the fundamental science knowledge and engineering skills of material structures and properties. This course demands multi-dimensional aspects from students to dive into interpreting the macroscopic behaviors, as based upon the basic principles of chemistry, physics, and mathematical

relationship. Importantly, students are ultimately expected to exhibit the abilities of solving realistic material science problems, and come up with effective engineering solutions through novel and useful material designs to enhance their service performance.

Applicable ABET Student Learning Outcomes

1) An ability to identify, formulate, and solve complex engineering problems regarding the reasons that different materials exhibit different physical properties by applying principles of chemistry, physics, and mathematics.

2) An ability to communicate effectively with a range of audiences regarding the articulation of property difference between crystalline and amorphous materials along with their corresponding applications by utilizing the knowledge of general chemistry, physics and thermodynamics.

3) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments by using the knowledge of material crystal structures and their properties, and most importantly, coming up with mitigation approach of material corrosion, fatigue and strengthening.

4) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions of the similarity and difference among metals, semiconductors and insulators regarding their detailed energy band structure, electronic structure and external stress effects (mechanical pressure, temperature, chemical doping, etc.).

Textbook

William D. Callister, Jr., David G. Rethwisch, Materials Science and Engineering: An Introduction, 10th Edition, Wiley, January 2018. ISBN: 978-1-119-40549-8.

Lecture Schedule

Wednesday 8:15-11:00 am, location: N210 New Building North

Teaching Assistant

Yifeng Liu, email: 2023141520057@stu.scu.edu.cn

Grading

Total score of the course grading is 100 points.

Homework: 20%

Class attendance: 10%
Midterm report: 10%
Midterm exam: 30%
Final exam: 30%

Grading Scale

90%-100%: A	85%-90%: A-	80%-85%: B+	
76%-80%: B	73%-76%: B-	70%-73%: C+	
66%-70%: C	63%-66%: C-	60%-63%: D	<60%: F

Exams

There will be two examinations of this course—midterm and final, which are to be tentatively scheduled on 05/06 week and 07/01 week of the spring semester, respectively. Exams are close-book, comprising questions including single-choice, Q&A, and mathematical calculation as the formats. A calculator is allowed for each student. Each exam weighs 30% of the course grade. Students are thus strongly suggested to study and prepare for the exams properly ahead of taking the tests.

Grading Dispute

If you disagree with the grading or to dispute wrongful errors made in the grading of an assignment, please bring it to the attention of TAs within one week of receiving the assignment.

Homework

Homework is based on problems after each chapter of the textbook, and will be posted on Blackboard system after the corresponding lecture. Homework score constitutes 10% of the class grading. Therefore, students are expected to submit after-class homework on time, within a week after the lecture, to avoid any deduction of credit. Collaboration with other students in the class is allowed. However, all rendered write-ups and papers must be individual works and any type of plagiarism will not be tolerated. If you have objection to the received score after getting your homework back, please notify the course teaching assistant. Please also take note of the following homework guidelines:

1) Your homework assignment must be completed in a Word format and submitted electronically through Blackboard system, with naming convention “Name-student ID-Hw#”. Handwritten assignments (or snapshots of handwritten works) will not be accepted.
2) Write your name, last four digits of student ID#, and class section# on top of the first page.
3) If you participate in collaboration with other students, please also put their names on the first page of the submitted homework.

Class Attendance

Attendance of lectures is mandatory as it constitutes 10% of the course's total grading. It is highly suggested that you come to class prepared, which includes reviewing last lecture's content, previewing lecture's content, reading online handouts, and going through potential problems, so as to enhance learning efficacy.

Make-up Policy

If you are retaking the course, TOEFL/IELTS schedule, sick leave with justified approval, or other issues that make you miss homework, reports, and/or exams, please inform TA and course instructor at your earliest convenience.

Accommodations

If you sustain disability or sickness that requires testing and/or classroom accommodations, please notify the course instructor, TA, and the university's Disability Resources and Services in time. You may be asked to present proof of disability or sickness to be provided the accessibility accommodations.

Academic Integrity

Plagiarism of any forms that include copying peers' works, writings, literatures, and online references without appropriate paraphrasing or full citations, cheating in an exam, infringing copyrighted works or other improper conducts constitutes academic dishonesty, and will be reported to SCUPI Academic Integrity Committee with the discretion of disciplinary actions of Sichuan University. It is a requirement that every student performs honest, independent, and righteous collaborations under the academic guidelines set forth by the SCUPI, Sichuan University, and University of Pittsburgh to ensure rightful learning performance.

Tentative Schedule of Course Contents

Below are the tentative lecturing schedule of course sections covered in this class:

Week	Contents	Descriptions
1 (03/11)	Chapters 1-2	Introduction to materials structures and properties, atomic structures and interatomic bonding
2 (03/18)	Chapter 3	Structure of crystalline solids
3 (03/25)	Chapters 4-5	Structural defects of solids, atomic and molecular diffusion in materials
4 (04/01)	Chapter 6	Mechanical properties of metals (stress-strain, elasticity, tensile properties, deformation, hardness, etc.)
5 (04/08)	Chapter 7	Dislocations and strengthening mechanisms of materials
6 (04/15)	Chapter 8	Failure behaviors of materials (fracture, ductile and brittle fracture, fracture toughness testing, cyclic stresses, *S-N* curve, crack formation etc.)

7 (04/22)	Chapter 9	Phase diagrams of materials (binary, ternary alloys etc.)
8 (04/29)	Chapters 10-11	Phase transformations, evolution of microstructures and mechanical properties; applications and processing of metal alloys
9 (05/06)	Chapter 12 & 13	Structures, properties, processing, applications of ceramics **(tentative Midterm exam in this week, subject to change)**
10 (05/13)	Chapter 14	Structures, shapes, configurations, crystallinity, defects, and diffusions in polymers
11 (05/20)	Chapter 15	Characteristics, applications, and processing of polymers
12 (05/27)	Chapter 16	Properties of composite materials (particle-reinforced composites, fiber-reinforced composites, structural composites)
13 (06/03)	Chapter 17	Corrosion and degradation of materials
14 (06/10)	Chapter 18	Electrical properties of materials (electrical conduction, semiconductivity, dielectric behaviors, ferroelectricity, piezoelectricity, etc.)
15 (06/17)	Chapter 19	Thermal properties of materials (heat capacity, thermal expansion, thermal conductivity, thermal stress, etc.)
16 (06/24)	Chapter 20	Magnetic properties of materials (diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, magnetic anisotropy, etc.)
17 (07/01)	Chapters 21-22	Optical properties of materials, environmental and societal issues in materials science and engineering **(tentative Final exam in this week, subject to change)**