ME 083 Fall 2004

Structure and Properties of Solids

Course Objectives, Grading Policy, and Course Syllabus

Course Schedule

Monday-Wednesday-Friday 10.20 am – 11.10 am
Room: 207 Hudson Hall (115A+222 together)

Instructors

Professor Stefano Curtarolo
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Teaching assistants

Scott Kennedy, 301 Hudson Hall, Phone: 660-5434, e-mail: scott.kennedy@duke.edu
Monica Rivera, 301-D Hudson Hall, Phone: 660-5375, e-mail: mr31@duke.edu
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Office Hours

Curtarolo: Wednesday 3.00-4:30 pm and by appointment
Zhelev: By appointment
Kennedy: TBA email/phone contact
Rivera: TBA email/phone contact
Lee: Monday 10:00-11:30AM
Sebba: Monday 3-4, Tuesday 1:30-2:30

Web-Site

http://alpha.mems.duke.edu/ME83/

Text Book

J. Shaffer, *et al.*,
The Science and Design of Engineering Materials (second edition)
ISBN: 0-256-24766-8, McGraw Hill, (1999)

Course Description

Introduction to the structure and properties of solid materials, emphasizing the relationships between the structure of a solid and its properties. Atomic and molecular origins of electrical, mechanical, and chemical behavior are treated in some detail for metals, alloys, polymers, ceramics, glasses, and composite materials. Lectures are accompanied by laboratory work. Prerequisites: Chemistry 11L and Mathematics 31 or 33.

Learning Objectives

Students successfully completing ME 83L will be able to:

(1) **describe** and **discuss** material properties and behavior in scientific and quantitative terms
(2) **understand** and **describe** the intimate link between material structure, properties and processing
(3) **apply** the fundamentals of chemical thermodynamics and heat and mass transfer to predict material properties quantitatively
(4)**integrate** objectives (1)-(3) to select an appropriate material for a given engineering application and to solve simple material design problems quantitatively.

Measurable Outcomes (assessment methods)

This course measures students' progress in meeting the above objectives by requiring them to:

(1) **select/propose** an appropriate material for a given engineering application under the constraint of certain performance requirements (homeworks, exams);
(2) **predict** the effect of thermal and mechanical treatments on the resulting structure/properties of engineering materials by applying an understanding of phase-diagrams and processing histories (homework, exams, lab reports);
(3) **apply** the principles of chemical thermodynamics to describe the driving force in material transformation processes (homeworks, exams, lab reports);
(4) **explain** the role of defects in controlling a variety of material properties (mechanical, thermal, electrical) (homeworks, exams);
(5) **analyze** heat and mass transfer problems in solids and to calculate simple heat and mass transfer problems (homeworks, exams);
(6) **conduct** selected materials testing experiments and describe in writing the results, demonstrating an understanding of the theory underlying the experimental methods (lab reports);
(7) **present** the results of materials testing experiments orally in front of an audience of peers (oral presentation);
(8) **integrate** analysis techniques and a basic understanding of material behavior to solve simple material design problems (homework, exams, lab report).

Grading

Interim EXAM I	20 %
Interim EXAM II	20 %
Final EXAM	20 %
Laboratory	25 %
Homework	25 %
Total	110 %

Grading Policy

Missed exams will equal 0 % unless the student has been excused by the instructor and arrangements for a make-up exam have been made.

Homework assignments are due one week after their assignment.
Points will be deducted if the homeworks are incomplete.
Solutions to all problems will be posted.
TA **David Sebba** is in charge of homework management.

Laboratory reports are due one week after the end of the experiment.
Points will be deducted if the reports are incomplete.
TA **Scott Kennedy** is in charge of laboratory management.

Problem Solving Suggestions

- FIND: What are you looking for?
- GIVEN: What information is supplied in the problem statement?
- DATA: What additional information is available form tables, figures, equations in the text, to solve the problem?
- ASSUMPTIONS: What are the assumptions made to solve the problem?
- SKETCH: What geometrical information is required? Visualize the problem!
- SOLUTION: A detailed step-by-step procedure. Do NOT enter numeric information until the final algebraic manipulation is completed. Check units and consistency.
- COMMENTS: Summarize the solution in words and comment on the consequences of the solution to the problem.

Special Needs

Any student in this course who has a disability that may prevent him/her from fully demonstrating his/her abilities should contact the instructor personally as soon as possible in order to discuss accommodations necessary to ensure full participation and to facilitate the educational opportunity.

Honor Code (`http://www.integrity.duke.edu/ugrad/student.html`)

The Duke Community Standard

Duke University is a community of scholars and learners, committed to the principles of honesty, trustworthiness, fairness, and respect for others. Students share with faculty and staff the responsibility for promoting a climate of integrity. As citizens of this community, students are expected to adhere to these fundamental values at all times, in both their academic and non-academic endeavors.

The Pledge

Students affirm their commitment to uphold the values of the Duke University community by signing a pledge that states: **1.** I will not lie, cheat, or steal in my academic endeavors, nor will I accept the actions of those who do. **2.** I will conduct myself responsibly and honorably in all my activities as a Duke student.

The Reaffirmation

Upon completion of each academic assignment, students will be expected to reaffirm the above commitment by signing this statement: "I have adhered to the Duke Community Standard in completing this assignment."[Student Signature]

Tentative Course Outline

Class Period	Inst.	Topics	Sections/Chapter
1–2	C	Introduction	Chapter 1 and Handout
3–5	C	Mechanical Behavior	9.1–9.2, 9.4
6	C	Atomic Structure	2.1–2.2
7	C	Atomic Bonding in Solids	2.4–2.8
8-9	C	Crystal Structures I	3.1–3.7
10	C	Crystal Structures II	3.8, 3.12
11–12	C	Defects	4.1-4.3, 5.1–5.4
13–15	C	Diffusion and Thermodynamics	4.4, and Handout
16–18	C	Electrical Behavior	Chapter 10
19–20	C	Optical Behavior	Chapter 11
21	C	INTERIM EXAM I	
22–26	Z	Polymeric Materials	6.1–6.4, 6.6
27–31	Z	Phase Equilibria	7.1–7.8
32–35	Z	Phase Transformations/ Microstructure	8.1–8.3
36	Z	Deformation Mechanisms	9.6
37	Z	Strengthening/ Hardening	5.5
38–39	Z	Processing and Design	5.5
40–41	Z	Composite Materials	Chapter 14
42	Z	INTERIM EXAM II	
	C &Z	FINAL EXAM	Comprehensive