ENGR 260 Engineering Materials, Cuyamaca College
Fall Semester 2007, Section 0725
Monday, Wednesday 7:30 – 8:55 pm, Room B103

ENGR 260 offers an introduction to material types and processing methods used in engineering. By the end of the course you should: 1) Have a broad knowledge of metals, ceramics, polymers, and composites, 2) Know the basic measures of material properties, including various measures of strength, hardness, etc, 3) Be able to relate macroscopic material properties to molecular structure and microstructure, 4) Know how to manipulate material properties through mechanical, chemical, and thermal means, 5) Be able to select a material for a particular application, and 6) Be able to do simple failure analysis.

Professor
Dr. Duncan McGehee
Office: B102
Work phone: 619-660-4242
Home phone: 619-298-4856. Please don't call after 10 pm, or before 7 am.
email: duncan.mcgehee@gcccd.edu, website: www.cuyamaca.edu/duncan.mcgehee
Office Hours: MW 5 - 6 pm, Th 12 – 1 pm, Sat 1 – 3 (in F301), or by appointment

Text
Materials Science and Engineering: An Introduction, 8th Edition, W. D. Callister & D. G. Rethwisch, 2010.
ISBN 978-0-470-41997-7 (hardbound version) OR ISBN 978-0-470-55673-3 (binder-ready version).

Units and Prerequisites
3 units, Prerequisites: CHEM 141 or equivalent, PHYC 190 or equivalent

Grading
A: 90 - 100
B: 80 - 89.9999
C: 70 - 79.9999
D: 60 - 69.9999
F: < 60

Homework	15%
Midterm Exam 1	25%
Midterm Exam 2	25%
Midterm Exam 3	25%
Final Exam	35%

<u>Notes on grades</u>:
1) There will be no make-up exams. However your lowest midterm grade will be dropped. Neither the final exam nor the homework will be dropped.
2) Homework will be assigned at the beginning of each topic, and will be due the Monday after the topic has been fully covered. For example (looking at the tentative schedule on the next page), the crystallography homework will be assigned 8 September and will be due 20 September. Don't dawdle on the homework: as soon as we get started on a topic, get started on the homework.
3) I will grade 2 homework problems from each homework set. These will be selected at random, unless there is one I'm particularly interested in. Each problem will be worth 5 points, so the overall homework set will be worth 10 points. The 5 points will be assigned as follows:

	Points
Problem statement: What is to be determined, what are the unknowns	1
Answer makes sense and is easy to follow	4

I will devote no more than 3 minutes to grading each problem. This should be ample if you've done a good job of laying out the problem. I'll make constructive comments, and will staple my solution for your consideration.
4) The lowest homework grade will be dropped.

Policies
1) Always read the material to be covered in class *before* the lecture.
2) Always bring textbook and calculator to class
3) Cheating. If I think you are cheating on a quiz:
   a) You will get a zero for that quiz
   b) I will invite you to withdraw from the class
4) Cell phones must be off before lecture begins. This includes text messages transmitted or received.

Important Dates
10 September: Last day to drop without a 'W'
10 November: Last day to drop classes.

Tentative schedule

Lesson	Date	Topic	Reading
1	30-Aug	Material Properties and Design 1	Ch 1
2	1-Aug	Material Properties and Design 2	Ch 6 (quick reading)
	6-Sept	**Labor Day**	
3	8-Sept	Crystallography 1	Ch 3.1-3.7
4	13-Sept	Crystallography 2	Ch 3.8-3.17
5	15-Sept	Density and Elastic Modulus 1	Ch 4.1 – 4.4, 6.1 – 6.2
6	20-Sept	Density and Elastic Modulus 2	Ch 2.5 – 2.7, 6.3 – 6.5
7	22-Sept	Strength and Ductility 1	Ch 6.6 – 6.10, 4.5 – 4.9
8	27-Sept	Strength and Ductility 2	Ch 7.1 – 7.7
9	29-Sept	Strength and Ductility 3	Ch 7.8 – 7.13
	4-Oct	**Midterm Examination 1**	
10	6-Oct	Fracture and Fatigue 1	Ch 8.1 – 8.6
11	11-Oct	Fracture and Fatigue 2	Ch 8.7 – 8.10
12	13-Oct	Diffusion and Creep 1	Ch 4.2, 5.1 – 5.4
13	18-Oct	Diffusion and Creep 2	Ch 5.5, 8.12- 8.15
14	20-Oct	Phase Diagrams 1	Ch 9.1-9.8
15	25-Oct	Phase Diagrams 2	Ch 9.9 – 9.17
16	27-Oct	Phase Diagrams 3	Ch 9.18 - 9.20
	1-Nov	**Midterm Examination 2**	
17	3-Nov	Phase Transformations 1	10.1 – 10.5
18	8-Nov	Phase Transformations 2	Ch 10.6 - 10.9
19	10-Nov	Metal alloys and thermal processing 1	Ch 11.1 – 11.3
20	15-Nov	Metal alloys and thermal processing 2	11.7 – 11.9
21	17-Nov	Metal alloys and thermal processing 3	Ch 11.4 – 11.6
22	22-Nov	Polymers 1	Ch 14
23	24-Nov	Polymers 2/Ceramics 1	Ch 15, Ch 12
	29-Nov	**Midterm Examination 3**	
24	1-Dec	Ceramics 2/Composites 1	Ch 13, Ch 16
25	6-Dec	Composites 2	Ch 16
26	8-Dec	Corrosion and degradation	Ch 17
	15-Dec	**Final Exam**	

subject to minor changes

Course Objectives (Expected Student Learning Outcomes)

Students will be able to:

1) Define and determine mechanical properties of materials including tensile strength, yield strength, hardness, stiffness, specific weight, melting temperature, toughness, hardenability. Apply these material properties to select the appropriate metal, ceramic, polymer, or composite material for a particular application.
2) Describe and explain the mechanisms for common mechanical and thermal processing techniques including strain hardening, case hardening, quenching, tempering, annealing, precipitation hardening. Describe and explain solid-solution strengthening. Describe industrial processes that employ these techniques (e.g. forging, drawing, annealing), and specify a series of processes to achieve desired mechanical properties in a metal.
3) Describe and explain various mechanisms for material failure, including ductile and brittle fracture, fatigue, and creep.
4) Relate macroscopic properties of materials such as melting temperature, modulus of elasticity, strength, electrical and thermal conductivities to the type and characteristics of their interatomic/intermolecular bonds.
5) Compare crystalline to noncrystalline materials. Sketch unit cells for face-centered cubic (FCC), body-centered cubic (BCC), and hexagonal close-packed (HCP) crystal structures. Compute material density using the unit cell concept. Specify directions and planes in FCC, BCC, and HCP structures and use them to explain the mechanism of plastic deformation in crystals.
6) Compute weight and atom percentages of the components of an alloy.
7) Explain edge and screw dislocations, how they are generated, and their role in strengthening metals.
8) Explain the mechanisms of solid-state diffusion, and apply Fick's first and second laws to compute the concentration of solute atoms as functions of diffusion distance, time, and temperature.
9) Explain the concepts of phase and microstructure in the context of a phase diagram. Apply the lever rule to compute relative abundance of the phases present. Use a phase diagram to predict the development of microstructure in equilibrium cooling. In particular, apply these techniques to eutectic alloys and to the iron-carbon system.
10) Explain phase transformation kinetics and use the concept to develop the isothermal transformation diagram for an iron-carbon alloy. Use the isothermal transformation diagram to predict the microstructure developed for a given cooling rate. Predict the mechanical properties in terms of microstructure.
11) Predict ceramic crystal structure from ionic charges and size ratios. Compare the mechanical properties of ceramics to those of metals and explain various ceramic applications and processing techniques.
12) Describe the mer structure, basic properties and basic processing techniques of some of the chemically simple polymers, both thermoplastic and thermosetting.
13) Explain the function of particle- and fiber-reinforced composite materials, and predict the mechanical properties of simple composite materials. List common composite materials and give examples of their applications.
14) Compare and describe the deteriorative (corrosive) mechanism for metals and ceramic materials and the degration behavior of polymers.

This course adheres to policies outlined in the Cuyamaca College Catalog. For further information, please see the section of the catalog entitled *Academic Policies*.