ESc 22 Mechanics II: Material Science **Winter 2005**

Instructor: Dr. Rapoff; 219 Steinmetz Hall; rapoff@union.edu; 388 8384

Lectures: Mondays, Wednesdays & Fridays 10:50 to 11:55 pm; N201 Science & Engineering Center

Labs: Wednesdays or Thursdays 1:45 to 4:35 pm; 005 Olin Hall (except as noted)

Office Hours: Thursdays 9:30 to 11:30 am & Fridays 1:30 to 3:30 pm, or by casual agreement

Text: Callister WD Jr. Materials science and engineering: an introduction. 6 e. John Wiley & Sons, 2003.

Course Web Site: See link at: engineering.union.edu/~rapoffa

Course Description: "A basic engineering science course required in several of the engineering curricula. The principles formulated in the science of materials allow engineers to understand the nature and behavior of a wide variety of engineering materials. This course provides the information for engineers to anticipate the properties of materials not yet studied or developed. Includes a laboratory where students build an intuitive appreciation for the phenomenon being discussed in lecture."

Homeworks: Homework problems are assigned and due as shown in this syllabus. Solutions must be organized, neat, and stapled; a specific format will be suggested and discussed in class. Solutions must represent the work of each individual student; any assistance provided to a classmate must be reported by the assisting student. Instructor solutions will be posted to the course website for a finite time period.

Exams: Three exams will be administered, the first two during regularly scheduled lecture time and the final during the final exam period scheduled by the College. A two dimensional letter size "crutch" sheet will be allowed. Other restrictions may be announced, e.g., no calculators may be allowed.

Extra Credit: Extra credit problems or quizzes may be assigned or administered during regularly scheduled lecture or lab periods. These points will add directly to the homework points.

Grades: Course grades will be determined using these weights: 20% for homeworks; 20% for the first, 20% for the second, and 25% for the final exam; 10% for the lab notebook, lab reports, and lab memo; and 5% for the poster presentation; and using this scale: $\geq$93=A, 90-92=A-, 87-89=B+, 83-86=B, 80-82=B-, 77-79=C+, 73-76=C, 70-72=C-, 60-69=D, and $\leq$59=F. All grading must be contested prior to the beginning of the lecture period following the period at which the original assignment was returned. These contestations must be accompanied by a written explanation of how your solution was incorrectly penalized.

Attendance & Punctuality: Each student will be responsible for knowledge of all scheduling changes and announcements made in class. No prior, late, or makeup assignments or laboratories will be administered, accepted, or allowed without a College approved excuse. Laboratory attendance is mandatory; laboratory absence will result in no credit for associated assignments.

Academic Conduct: From the Student Handbook: "As a student at Union College, [we] hereby dedicate [ourselves] to living and working as part of the Union community, and to support and uphold the following principles: academic openness in the pursuit of knowledge, academic honesty, awareness of and respect for others' rights - regardless of race, creed, sex, sexual orientation or position, and dignity and pride in [ourselves], [our] actions, and [our] College."

Students with Disabilities: From the Disabled Student Services web page: "The Director of Student Support Services provides assistance to students with disabilities ... Students with disabilities who require accommodations must make a formal request by submitting documentation of the disability and accommodations requested." Please present the approved request to the Instructor within the first two weeks of the term, in total confidence and at your discretion.

ESc 22 Mechanics II: Material Science — Lectures & Assignments

Week	Class	Day	Date	Month	Sections	CHAPTER Topic	HW
1	1	M	3	January	1.1-7	INTRODUCTION	**HW1 out**
	2	W	5	January	2.1 2.2-4	ATOMIC STRUCTURE AND INTERATOMIC BONDING Atomic Structure	**HW1 due** **HW2 out**
	3	F	7	January	2.5-8	Atomic Bonding	
2	4	M	10	January	3.1 3.2-7	THE STRUCTURE OF CRYSTALLINE SOLIDS Crystal Structures	**HW2 due** **HW3 out**
	5	W	12	January	3.8-12	Crystallographic Points, Directions, and Planes	
	6	F	14	January	3.13-17	Crystalline and Noncrystalline Materials	
3	7	M	17	January	4.1 4.2-4	IMPERFECTIONS IN SOLIDS Point Defects	**HW3 due** **HW4 out**
	8	W	19	January	4.5-8	Miscellaneous Imperfections	
	9	F	21	January	4.9-11	Microscopic Examination	
4	10	M	24	January	5.1-6	DIFFUSION	**HW4 due** **HW5 out**
	11	W	26	January		Exam Discussion & Review	**HW5 due**
	12	**F**	**28**	**January**		**Exam 1**	
5	13	M	31	January	6.1-2	MECHANICAL PROPERTIES OF METALS	**HW6 out**
	14	W	2	February	6.3-5	Elastic Deformation	
	15	F	4	February	6.6-10	Plastic Deformation	
6	16	M	7	February	7.1 7.2-7.7	DISLOCATIONS AND STRENGTHENING MECHANISMS Dislocations and Plastic Deformation	**HW6 due** **HW7 out**
	17	W	9	February	9.1 9.2-5	PHASE DIAGRAMS Definitions and Basic Concepts	**HW7 due** **HW8 out**
	18	F	11	February	9.6-15	Equilibrium Phase Diagrams	
7	19	M	14	February	9.17-19	The Iron-Carbon System	
	20	W	16	February	10.1 10.2-4	PHASE TRANSFORMATION IN METALS Phase Transformation	**HW8 due** **HW9 out**
	21	F	18	February	10-5-9	Microstructural and Property Changes in Iron-Carbon Alloys	
8	21	M	21	February		Homework Discusison	**HW9 due** **HW10 out**
	22	W	23	February		Exam Discussion & Review	**HW10 due**
	23	**F**	**25**	**February**		**Exam 2**	
9	24	M	28	February	12.1 12.2-7	STRUCTURES AND PROPERTIES OF CERAMICS Ceramic Structures	**HW11 out**
	25	W	2	March	12.8-11	Mechanical Properties	**HW11 due** **HW12 out**
	26	F	4	March	16.1 16.2-3	COMPOSITES Particle-Reinforced Composites	**HW12 due** **HW13 out**
10	27	M	7	March	16.4-13 16.14-15	Fiber-Reinforced Composites Structural Composites	
	28	W	9	March		Poster Session	**HW13 due**
	29	F	11	March		Exam Discussion, Review & Course Evaluations	
Finals	**30**	**R**	**17**	**March**		**Final Exam 1:00 - 3:00 pm 115 Olin Hall**	

Laboratories: The laboratory sessions are designed to supplement the class lectures and to give you opportunity for hands-on work. A lab notebook is required to document your work.

Week	Date	Month	Topic
1	5 or 6	January	Crystal Structures and Crystallography
2	12 or 13	January	Quantification of Grains and X-Ray Diffraction
3	19 or 20	January	Mechanical Properties of Everyday Materials - Memo
4	26 or 27	January	Tensile Testing of Metals and Polymers - Lab Report
5	2 or 3	February	Compression Testing of Natural and Man-made Composites - Lab Report
6	9 or 10	February	Heat Treatment of Binary Alloys - Poster Part I
7	16 or 17	February	Hardness Testing and Polishing of Post Heat-Treated Binary Alloys - Poster Part II
8	23 or 24	February	Etching and SEM Analysis of Post Heat-Treated Binary Alloys - Poster Part III
9	2 or 3	March	Temperature Dependence of Elasticity on Silicone Bouncy Balls - Lab Report
10	9 or 10	March	Ferrofluids

Laboratory Safety: There is nothing more important than your safety in the laboratory. There are some common sense guidelines we need to follow to ensure that everyone has a safe, enjoyable experience:

- All students must wear long pants, or other appropriate clothing, that covers the legs and shoes with socks. No shorts, skirts, dresses, sandals, or open-toed shoes are permitted.
- Confine long hair when in the laboratory.
- Safety glasses must be worn in the laboratory.
- Listen and follow the specific rules of each lab session, e.g., wear gloves when using high temperature ovens and do not wear gloves when grinding samples.
- No food (including candy or gum) is permitted in the lab.
- No horseplay or other acts of carelessness will be tolerated.
- Unsupervised experiments are not allowed.
- Report any accidents or injuries, however slight, to the Instructor.

Lab Groups: Each lab section may be divided into groups. If you are in the lecture section of this Instructor and if you are in a lab section of this Instructor and if it is announced that the lab will be divided, then you should participate in your lab session from 3:10 to 4:35 pm..

Maintaining Detailed Laboratory Notebooks: Keeping a detailed laboratory notebook is good engineering practice that has purposes and applications in academia and industry. It can be used to support the validity of results reported to peers and funding resources; as evidence for proving inventorship or first-to-invent; and as a detailed documentation for reference for future work.

What to Put in a Lab Notebook: Anything that pertains to research, project development, or an experiment. Lab notebooks always include a table of contents that references on what page each subsequent lab data are documented.

Preparation Work: Record all research and development efforts including ideas generated during brainstorming sessions. Record dates when an idea was formed and when work on the idea was started and completed. Record plans for future experiments and action items. Write down conversations with others or discussion items in lab team meetings. If work is being divided in a team situation, record who is doing what. Clearly title the occasion, the people present, and the date. Preparation work also includes setting up the notebook with the title, purpose and procedures of the experiment before the actual experiment. Completion of a pre-lab assignment might also be required in the preparation.

SECTIONS OF THE LAB NOTEBOOK

Title: Maintaining Good Lab Notebooks

Purpose: A well-maintained lab notebook should reflect good, up-to-date documentation and organization of each step of the scientific method in which you performed to accomplish laboratory experiments.

Procedure: How? A few procedural guidelines:

- Experiments should be clearly separated in sections by new titles.
- Entries should be permanent, complete, and continuous.
- Use a bound notebook with numbered pages to prove that the entries have not been forged or altered by replacement, deletion, or insertion of pages.
- Entries should be made consecutively. No pages or spaces on pages should be skipped. If blank pages are left on a page or pages are skipped, then a line should be drawn through them to demonstrate that the blank spaces are intentional.
- Use ink. Do not use pencil or color coding. Write legibly. Do not erase. If changes must be made (e.g., errors corrected), the erroneous information should be lined through, dated, and signed. Reasons for alteration should also be noted if they are not obvious.
- Leave a few pages at the beginning of the lab notebook for an index and a glossary defining trade names, acronyms, codes or laboratory jargon.

Results: This section includes all data: figures, tables, and calculations.

- It is better to include more (relevant) information than not enough, to err on the side of thoroughness and completeness, e.g., record external anomalies that might have affected your data.
- Lab notebooks should contain enough information so that a technically sophisticated outsider will be able to understand what was done without assistance of the person who actually made the entries, or be able to repeat the experiment themselves without the help of the author.
- Results should follow a consistent procedure of being promptly and accurately recorded. This is only reasonable since waiting a day or longer before making an entry diminishes its value as details and observations may be forgotten.
- Test results obtained at a later date should be recorded on a separate page and cross referenced to the page containing the earlier entry.
- Include extrinsic materials, such as raw data from recording instruments, drawings, photographs, charts, computer printouts, specification sheets.
    - Permanently glue or tape these materials in the notebook, sign, and date.
    - The signature should cross both the attached material and the notebook page.

Conclusions: This section states any conclusions you have regarding data and why or why not expected results were obtained. It can be expanded if a full report or presentation is required. Answers or thoughts to any post-experiment questions can be recorded and discussed here.

Verification: The Instructor will verify your lab results by signing and dating the bottom of each page of entries in your notebook after each experiment. It is also suggested that a fellow team member verify your lab results by signing his or her initials next to the results section of each experiment. This is a good opportunity for lab members to discuss the experiment, make sure that everyone had access to all the experimental data, and to keep the notebook organized.