MSE 3020 - MATERIALS LABORATORY

Instructors:

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Dr. Lisa Rosenstein, (404) 385-0347, lisa.rosenstein@ce.gatech.edu

Learning Objectives:

The objective of this laboratory course is to introduce the four major aspects of materials science and engineering: (1) synthesis and processing of the different classes of materials, (2) characterization of the materials microstructure at different stages in the processing (3) mechanical, thermal, and other treatments to modify the materials microstructure, and (4) introduce the basic methods of mechanical, electrical and optical property characterization. Emphasis will be placed on proper logbook recording of data, skillful technical writing of reports, and safe laboratory practices.

Course Format:

There will be laboratories in five major materials areas consisting of hands-on laboratory experiments spread over the 15-week period. Demonstrations of specialized equipment, videos, and field trips will also be arranged (see attached schedule). A separate lecture hour will introduce lab topics as well as the basics of technical writing and safety in the laboratory.

Laboratory topics, instructors and timing are shown below. Technical communications and writing will be presented and reinforced throughout the course as shown in the schedule.

1. Mechanical Properties of Metals	Dr. Steve Johnson & N. Thadhani	Jan 5 - Jan 23
2. Ionic Conducting Materials	Dr. Meilin Liu	Jan 26 - Feb13
3. Ceramic Processing	Dr. Joe Cochran	Feb16 – Mar 5
4. Dielectric Materials	Dr. Rosario Gerhardt	Mar15 - Apr 1
5. Polymers	Dr. Rina Tannenbaum	Apr 5 - Apr 23
6. Technical Writing	Dr. Lisa Rosenstein	All Semester, See Schedule

Requirements:

A lab notebook is required. Students must have TAs review and initial lab notebooks after each laboratory. Lab notebooks will be turned in with the final lab report. Lab reports are to be turned in according to the schedule (see lab report guidelines and attached schedule). A final exam will be scheduled during exams week.

Grading:

Lab Reports (60%)*, Lab Participation/Attendance (10%), Logbooks (10%), Final Exam (20%)

**(Lab report grading criterion – 30% writing style and 70% technical content.)*

References:

1. James Reed, Ceramic Processing,

2. James Schaffer et al., The Science and Design of Engineering Materials,
3. James F. Shackelford, Introduction to Materials Science for Engineers
4. W.D. Kingery et al., Introduction to Ceramics
5. Kumar and Gupta, Fundamentals of Polymers
6. S.D. El Wakil, Materials Science and Engineering Lab Manual
7. Lannon, "Technical Writing," Longman, 1996

MSE 3020
Guideline for Using Laboratory Notebooks

- Laboratory notebooks should be permanent, complete and continuous.
- Use a permanent bound notebook with numbered pages. NEVER remove pages.
- Make entries consecutively. Use every page (front and back).
- SIGN AND DATE all entries. This is done by including a set of entries between a heading that specifies the subject of the entries to follow and the date, and a trailer that consists of your dated signature.
- Use indelible ink for all entries.
- All entries should be legible.
- DO NOT ERASE. Line through erroneous entries. Date and sign all corrections.
- Include enough detail so that a knowledgeable person could understand what you did without your assistance.
- Err on the side of completeness.
- Record what was done, who did it, what directions were being followed, what instruments were used (be specific), when it was done (see above re. dating entries).
- Include raw data, drawings, photographs, instrument outputs (copies of many such items can be permanently glued or taped into the notebook (do not use staples or paperclips) - these should be signed and dated).

- **At the conclusion of each laboratory, have a teaching assistant review your notebook entries for the laboratory and sign and date them. The TA should give you feedback on how well you have complied with the above guidelines.**
- **Your lab notebooks will be turned in at the end of the semester and graded. The lab notebooks will count for 10% of the course grade.**
- DO NOT INCLUDE personal matters, lecture notes, or material from other

courses.

LABORATORY REGULATIONS

1. **Arrive to lab on time**. After checking the roll at 1:35, lab begins promptly after. Students arriving more than 10 minutes late without a valid excuse will receive a late penalty on their incoming lab.

2. Strict attendance records will be kept. If you miss a lab, you will be required to make it up. If possible, you may make it up during another regularly scheduled lab session. However, you must receive permission from the TA in charge of that lab. No one will be allowed to attend a lab section to which they are not assigned without permission. **WE URGE YOU TO NOT SCHEDULE JOB INTERVIEWS, DOCTOR APPOINTMENTS, ETC. DURING YOUR LAB PERIOD.**

3. Lab reports are due one week after the lab is conducted and should be turned in to the TA during the next lab period (and not to the TA you had the week before).

4. If you know you are going to miss a lab, the report must be turned in before the lab period, not after. **Any lab received late will be penalized 5 points per day** from the due date. **NO ONE WILL BE ALLOWED TO TURN IN ALL THEIR LABS AT THE END OF THE QUARTER AND EXPECT A PASSING GRADE.**

5. Turn in only your own work. **If you are caught cheating, e.g. copying someone else's lab verbatim, you WILL RECEIVE A ZERO on that lab report**. Do not plagiarize; the lab manual and reference books are to be used as reference sources only.

6. **Safety glasses must be worn at all times.** They may be purchased at the bookstore. You will not be permitted to participate in the lab without safety glasses, so please come prepared. Shirt and shoes are also required at all times.

7. **Do not forget to bring your logbooks and WRITE IN THEM!!**. They can be purchased at the bookstore and must be glue-bound notebooks. All entries must be made in black ink and signed and dated. Logbooks are used to record all details pertaining to the lab such as equipment identification and description, accuracy of measurements, procedures used, specimen identification, calculations, observations, personal comments and any other information required to ensure repeatable lab work. Each entry should include date, time, location, experiment number and person performing work being described.

8. **Come prepared.** Please read the sections pertaining to your lab ahead of time and be prepared to answer some short questions at the beginning of the session. Make some notes in your logbook about what you expect to learn.

ALL STUDENTS ARE EXPECTED TO ABIDE BY THE GEORGIA STUDENT HONOR CODE

AND AVOID ANY INSTANCES OF ACADEMIC MISCONDUCT. FOR MORE INFORMATION ON THE HONOR CODE SEE: www.honor.gatech.edu

LABORATORY SAFETY GUIDELINES

Introduction:

Lab safety should always be the first consideration when working in the laboratory. Although the laboratory work performed in this course will not be extensive, a discussion of brief safety points is covered in this appendix. In addition, the common sense approach to safety should always be applied as well as a consideration for others while working in the laboratory.

Accidents and Emergencies [**ON CAMPUS POLICE, FIRE, AMBULANCE: 894-2500**]

In the case of a medical or other medical emergency, the phone number above should be called. Dialing 911 is not recommended due to the location on the GA Tech campus. Please be sure to inform the dispatcher that an ambulance, etc. is needed if desired and what kind of emergency is at hand. In the case of a fire, the proper fire extinguisher should be employed and the doors should be closed in conjunction with the disconnection of gas and electrical lines/circuits. Safety showers and the **stop**, **drop**, and **roll** principle should be implemented in case articles of clothing are on fire. In the case of chemical exposure to the skin, wash off chemicals with cold water followed by washing with soap and water. Removal of clothing and jewelry from the affected area may also be necessary. In case of chemical exposure to eyes, running water should be applied for 15 minutes while the eye is open paying careful attention to douse the inner eyelid as well. If available, an eye wash station should be used.

Protective Clothing

Eye protection is a vital aspect of lab safety. Students are required to provide his or her own safety glasses and to have them at all times when working in the laboratory. Safety glasses can be purchased in the GA Tech bookstore and at a variety of other stores (e.g.- hardware stores, scientific supply houses, etc.). Students that have prescription glasses are advised to provide side shields for enhanced safety from flying objects. Contact lenses should never be worn in the laboratory!

Proper clothing should be worn to adequately protect exposed body parts (i.e. Shorts, skirts, and tank tops should not be worn). Gloves and aprons are recommended for handling chemicals and should be available in the lab area. Loose fitting articles such as jewelry and neckties should be avoided so as not to get caught in machinery. Solid toed shoes should be worn at all times. Sandals and open toed shoes offer little or no protection and should be avoided.

Chemical Safety

Chemical exposure in this laboratory will most likely be due to acids and bases used as etchants for metallographic samples to outline the microstructure. Great care should be taken to avoid skin and eye contact with these chemicals. The FUME HOOD should always be used in conjunction with proper protective gear (i.e. gloves, eye protection, and apron) when handling these chemicals. Waste should be placed in a properly labelled container with contents, date, and T/A's name and/or class name. The MSDS (Materials Safety Data Sheet) should be consulted for questions. Ask the T/A if not available.

The information provided in this section is summarized from the Safety Manual of the School of

Materials Science and Engineering and should be consulted for more in depth information.

School of Materials Science and Engineering
Georgia Institute of Technology

Lab Report Preparation Guidelines

Prepared by
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School of Civil and Environmental Engineering

(revised)
July 25, 2002

Lab Report Sections

Title Page
(all information to be centered)

- Title of Lab
- Student Name
- Course name and #
- Laboratory #
- Date

Table of Contents

- Requires that the entire report be paginated
- First item will be List of Figures and Tables

List of Figures and Tables

- Include the Figure/Table number and the entire figure caption or table title
- Order them in the order in which they appear in the report. Do not make a separate list of figures and a separate list of tables.

Abstract

Your abstract must include the following information in the following order:

- The objective of the experiment
- A brief explanation of your methodology
- A summary of your results (give numerical values, if applicable)
- An explanation of the larger significance of your work ("The results suggest…" or "The results indicate…")

Two optional elements of an abstract are "Background" and "Scope." Background information often explains the motivation or engineering context of the experiment. Scope defines the limits or parameters of the experiment. If you choose to include a background statement, place it before the objective statement. If you choose to include a scope statement, place it after the objective statement.

Abstracts should:

- Be one paragraph in length
- Be written in the present tense (except methodology, which can be written in the past tense)

Abstracts should not:

- Include extensive background material, i.e., no developed discussion of the problem (or need) that led to this work; however, as stated above, you might include a brief reference to the problem in relation to the objective of the experiment.
- Cite literature references
- Refer to any other part of the report
- Include figures, tables, equations, or footnotes

Introduction

- An introduction explains the larger intellectual/scientific context of the experiment: it provides the reader with background information.

- It also answers the following question: "Why was this experiment needed?" In this way it supplies the motive for the experiment.

- An introduction also connects the larger context with the specific experiment.

Your introduction must include the following information:

- A short literature review (who has been working on this? What is already known?) that covers some important aspects of the laboratory. You must use a reference from a textbook or journal; lab handouts/manuals are not acceptable references.
- A description of the scientific/real world context of the lab. Describe the problem or need that prompts such an experiment. For example, if the main objective of the lab is to measure grain size in a metal alloy, explain why knowing grain size is important to understanding the metal alloy's mechanical properties.

Procedure

- In this section you are to summarize what was done in the lab. Write in paragraphs, not numbered steps. If any given procedure is standard, then it can be referred to by name.

- In your effort to faithfully recount what transpired in the lab, don't go overboard and try to account for every little action you engage in. Report activities central to the successful completion of the lab, not ones that are part of most experimental procedures.

- Do not refer the reader to a laboratory handout for "further information"; the reader may not have it. Fully describe or visually display all pertinent information. If you use figures, make sure to number and caption them and label all significant parts.

- While the experimental procedure should be a concise description of the steps performed in the lab, it must not explain why certain steps were taken. These explanations should be included in the Discussion section of the report. For example, in a previous MSE lab a number of students wrote that "a graphite rod was used to stir the melt. An iron or steel rod was not used because these materials are soluble in liquid aluminum." The last sentence should be placed in the Discussion section and expanded.

Results

- All of the data collected during the lab must be reported here. The data must be presented in SI units. It is often useful to create summary tables to illustrate comparisons among data.

- Place the bulk of the raw data in an appendix.

- DO NOT analyze, interpret, or explain any data.

- The results section is a combination of visual and written elements. However, the written elements merely describe the visual elements; they do not interpret or analyze them.

- If qualitative observations were made during the lab, then the description of these observations is also considered a result and should be included here.

- This section may also include a plot of an obtained result to make the discussion easier.

For example, you might include a plot that shows grain size as a function of cooling rate. In the case of multiple data points, where, for example, grain size measurements were performed on 10 different photographs, plot the average values and show error bars.

Discussion

- This is the section in which you will use your critical thinking skills. You will now interpret, explain, and analyze the data. If you don't do this, the reader might a) not see what you are trying to prove; or b) misconstrue what you are trying to prove.

- The data should be discussed in relation to what is expected in theory. Remember, discrepancies in the data are not incorrect; they should be noted and discussed. For example, "This feature does not correlate with what is expected but could be due to...".

- Analyze error.

- Always use a line of best fit, and avoid using a "connect the dot" approach.

Conclusions

- Provide two or three conclusions based on the data collected in the lab.
- Make sure the conclusions are directly related to the data collected in the lab. For example, if mechanical property tests were not performed, then you cannot conclude that the small grains measured are good for mechanical properties.

- Make sure that your conclusions are not just reiterated results but rather insights you can draw from the results.

References

- The references cited in the lab must be listed here in standard documentation form.

- Make sure that all of the references included at the end of the report have been cited in the body of the report.

Visual Elements in Lab Reports

Figures

All figures must be numbered and captioned below the figure. The caption must concisely describe the content of the figure but also be detailed enough so that the reader can understand the figure without reading the text.

You must:
- Label all parts of diagrams
- Include a legend in graphs

- Include units of measurement in graphs
- Use an appropriate scale in graphs

Tables

All tables must be numbered and titled above the table.

You must:
- Keep columns and rows even
- Include headings for all columns and rows
- Line up decimal points (if applicable)

Finally:
All visuals must be referred to in the text before they appear in the report. You cannot refer to figure 1, for example, after the figure appears in the text; this is too late. The reader must be told that this figure is coming.

Sentence Style in Lab Reports

First Principle of Style: Because sentences in technical reports need to be impersonal, empirical, and objective, agency is often omitted. The reader knows that you (the design team/the lab group) have done the described work; therefore, you don't need to constantly appear as the subject in the sentences. What should appear as the subjects of your sentences are the things (or forces) that you are studying.

Example:
Not this: We found that the pressure varied with changes in temperature.
But this: Pressure varied with changes in temperature.

Second Principle of Style: **Furthermore, experiments require observation, so you should expect to use some verbs associated with seeing. Phenomena are "observed," "seen," "found," and "shown," and values are "calculated" and "determined." These are things that you do, but because you don't get to appear as the subjects of your sentences (see above), you must often use the passive voice in order to maintain an impersonal stance while still recounting your work faithfully.**

Example:
Not this: We used Equation 4 to determine the Reynolds number.
But this: Equation 4 was used to determine the Reynolds number./ The Reynolds number was determined using Equation 4.

Third Principle of Style: Finally, technical documents must be written with an eye to specificity. Therefore, modifiers (adjectives, adverbs) that are too general--"large," "quickly," "slowly"--are not only inappropriate, but ultimately useless in scientific reporting. Reporting exact numbers is one way to avoid generalizations.

Example:
Not this: A large sample was heated to a high temperature for a long time; then it was cooled quickly.
But this: A 70 gram sample was heated to 200 degrees F for 4 hours. It was then cooled to 0 degrees F over the course of 20 minutes.

Fourth Principle of Style: Keep your verb usage consistent; do not vary your verbs in order to make the material "more interesting."

Example:
Not this: In Region I, crack growth is affected by the dimensions of lath martensites; in Region II, it is dependent upon the size of martensite packets; in Region III, crack growth was influenced by prior austenite grains.
But this: In Region I, crack growth is affected by the dimensions of lath martensites; in Region II, it is affected by the size of martensite packets; in Region III it is affected by prior austenite grains.

MSE 3020 Laboratory Report Grade Sheet

Student Name _____

	TECHNICAL CONTENT		**TECHNICAL WRITING**	
	Possible Points	Points Awarded	Possible Points	Points Awarded
Overall	5		N/A	
Abstract	10		4	
Introduction	10		4	
Procedure	10		3	
Results	10		4	
Discussion	15		N/A	
Conclusion	10		3	
Writing: Mechanics	N/A		3	
Writing: Technical Style	N/A		3	
Graphics: Design	N/A		3	
Graphics: Integration	N/A		3	
TOTAL	70 (Possible)		30 (Possible)	
GRAND TOTAL				