PHYS 4410, Materials Characterization Laboratory

Instructors:
Dr. Colin Inglefield SL 204 626-6127 cinglefield@weber.edu

Text:
Materials Characterization: Introduction to Microscopic and Spectroscopic Methods by Leng

Course Structure Summary: (More details below.)

1. The labs meet twice a week.
2. There will be three lab groups, you will work in groups of two or three.
3. All students will maintain a laboratory notebook for all the labs.
4. Each student will write weekly laboratory reports over the course of the semester.
5. Each student will write a formal, publication ready report.
6. There will be a one-hour practical skills final exam.

Course Structure Details:

1. **Lab Meeting Time:** You may work in the labs anytime you wish. Your instructors will be available during the scheduled lab times (MW 2-5 p.m.), and you should not expect them to be readily available at other times. It is strongly suggested that you do the majority of your work, especially data collection, during the scheduled lab times.

2. **Lab Groups:** You will work in teams of 2 or 3. Everyone is expected to be an active participant. Your instructors reserve the right to reassign the team members if there are major conflicts, but don't count on it since the pacing of the lab is pretty tight and changing groups will be hard.

3. **Capstone Lab (10% of your grade):** By the end of the semester you should be comfortable enough to work more independently. More information will be made available as time approaches.

4. **Laboratory Notebook (10% of your grade, "spot-checks" throughout the semester):** Each of you must have a bound laboratory notebook. It must be a professional style lab notebook ***not*** a spiral bound or loose leaf notebook. This is an extremely important book!
    - Everything you do should be in this book. Do not use scratch paper for anything; put it all in the notebook. If you make an error or want to discard a page in the book, do not remove it, just simply draw a large clear "X" over the page or draw a single clear line through the data point. You should still be able to read the old information through your cross-out. (You never know, you might actually decide that some of it is important later!)
    - You should include sufficient detail so that you, or one of your peers, could later reproduce what you did. Every page should be clearly dated. As needed you can *literally* cut and paste in graphs, data tables and/or diagrams.
    - Neatness is important but remember that this is a **Note**book where you jot down your thoughts, results and actions. Do not write stuff down on scratch paper or in a "sloppy" book then rewrite it later in the "real" notebook. However, your writing MUST be neat enough to be easily read by anyone else. Make clear and readable data tables and sketches. In the end, it is not your instructor's job to decipher things. If it is not clear and easy to read and understand, then it will be considered as incorrect.
    - All questions in the lab handouts should be clearly indicated and answered in the lab books. (See the grading rubric below.)
    - As professional scientists you should always be alert to ways to improve any given measurement or activity. Your error analysis can guide you here. Train yourself to look for

ways to make improvements to the weak parts of the experiment and then clearly record those ideas in your notebook. I.e. if you were going to do this experiment again, what would you change to make it better and more accurate?

5. **Weekly Laboratory Reports (30% of your grade):** When a lab report is required for a particular week (see the schedule) you should submit a report, as a group, by the start of class on Wednesday of the following week. Each member of the group is expected to participate in the writing of all the lab reports and you will share the grade on the report.
    - Each student will be the "lead author" on two reports. The lead author is the one who did most of the writing and the others did the proof reading and suggestions for revision. The lead author's name always appears first. This responsibility should alternate between research team members for the different reports.
    - The report should be written as though it was an executive summary to a lab manager or customer. Your reputation, job and/or future clients depend on the quality of this report. It should be concise but complete. You should have the following sections in every report:
        1. Title, date and authors
        2. Summary: A short summary of the task that was accomplished and how it was accomplished, i.e., an abstract.
        3. Data analysis: A brief description of how you analyzed your data. You do not need to include all your data, but you must include enough data to justify any graphs and the conclusions drawn. This section will contain any equations of merit or a discussion of the statistical analysis used. This section should include an analysis of the uncertainties, i.e. a sample of each of the propagation of errors calculations that you did. List your final data in a clear table or other format as appropriate.
        4. Results: A section that includes final data and important results. Summarize your final results, including the uncertainty and a comparison, where appropriate, to expected (accepted) values.
        5. Discussion: This section should clearly include any questions (and, of course, the answers) that were asked in the handout. If there are anomalies or notable comments about your data, they should be included in this section. This is a good place to include comments about what you would change or do differently if you were to do this set of measurements again.
    - Everything should be typed, including the equations (your instructors can help you with this). All graphs should be done with a spreadsheet or other software.
    - The other authors should proofread the report carefully. Especially for the first lab report, you are strongly encouraged to get feedback from the instructors during the writing process. The reports account for 30% of your grade with all authors sharing the same grade.

6. **Formal Report (20% of your grade):** Each of you will prepare a report in the style of an AIP journal article, professional and publication-ready. Consult an AIP journal for a general idea. You will turn in a draft of the report in during week 11 and the final version of the report in week 13. You should use the AIP style manual, which can be found at http://www.aip.org/pubservs/style/4thed/toc.html.

7. **Professionalism (10% of your grade):** Professionalism includes coming to lab on time, being prepared, assisting the team in conducting each experiment, participating in the writing and proof-reading of group lab reports, etc. Each student will receive a separate grade based on the level of professionalism and contribution that he/she demonstrates.

8. **Practical Lab Final Exam (20% of your grade):** At the end of the semester, you will have an opportunity to demonstrate the skills and knowledge you have gained over the semester. The final may

include such exercises as using some apparatus from one of the experiments, graphing or otherwise processing some data, and/or doing a calculation involving the propagation of error.

Other Important Information

Academic Dishonesty: In a laboratory course, academic dishonesty would most likely be due to the fabrication of data. For whatever reason, some students, who would never cheat on an exam, will fabricate data in the laboratory. Neither will be tolerated in this course and could result in a student receiving a failing grade for the course.

Working in the Nuclear Lab: Prior to working in the nuclear lab each student will receive a one hour lecture on radiation safety procedures. (This is scheduled for the first week of classes.) For the nuclear experiments, you will be assigned a film badge, which should be worn while you are working with the radioactive samples. This is standard procedure whenever a person works with radiation of any sort. In addition, you should read the information posted on the door of the nuclear lab and follow the safety precautions. It should be noted that women who are pregnant may make that information known and will be supplied with an additional fetal monitor badge. Making that information known to the instructor(s) is strictly voluntary.

PHYS 4410, Materials Characterization Laboratory
Grading Policies

Summary of grade break down:

Laboratory notebooks (individual):	10%
Weekly reports (group):	30%
Formal report (individual)	20%
Capstone (individual):	10%
Professionalism (individual):	10%
Practical lab final exam (individual):	20%
Total	*100%*

VERY IMPORTANT NOTE REGARDING GRADING: Since this is an upper division laboratory course intended to prepare students for laboratory work in graduate school, industry or other such environments, students are strongly encouraged to conduct laboratories with this in mind. These laboratories are NOT intended to be step-by-step procedures to be followed exactly. Students should feel free to think beyond what is included in laboratory handouts, try things, figure things out and if you notice an issue which is not mentioned in the laboratory handouts, look into it and include your results in notebooks and/or laboratory reports. Read the grading rubric below very carefully. **If you perfectly follow all laboratory instructions, and correctly calculate data and answer all questions you will receive an 18/20** (which is a very respectable grade). The top grades will be given to students who go beyond what is given in the laboratory handouts (ex: collecting additional data, show further insight, conduct additional research, etc.).

Summary:	Description:	Score:
Very Professional Extensive Analysis Exceptional Detail No Flaws/Errors Perfect Grammar Concise Writing Insightful Answers Clear & Easy to Read	**Extraordinary work and effort** This assignment was completed with an extraordinary amount of effort. Not only were all aspects of the assignment completed accurately and completely, but this report showed extra insight, clarity, effort and research. Extensive additional data runs and analysis may have been done and/or library and Internet searches for more background theory and history. This score is received on a small minority of projects. All optional components to the lab were done with care and extra attention to detail and analysis.	20/20 A+
Very Clear Additional Analyses No Errors Detailed Answers Optional Work Done Perfect Graphs	**Remarkable work that clearly stands out above the others.** This assignment was completed accurately and completely. Any errors in this assignment are insignificant. Essentially, this score is reserved for efforts which reflect total integrity and accuracy, and *are more sophisticated than the average report.* This project may have been completed with extra data runs or additional research. The student learned more from this lab than most students in the class. Detailed answers clearly relating to the data with examples to back up the point being made. All optional parts have been done.	19/20 A
Does exactly what needs to be done, maybe a little more but nothing less. No significant flaws. Clear Answers Acceptable Graphs	**High quality work that meets all defined requirements.** **Most adequately completed work will receive this grade.** This is good work of high quality. It was complete and accurate with no significant errors. The point of the activity is well conceived. Answers are clear and to the point. This student put an adequate and earnest amount of work into the assignment and it is evident that s/he learned something from it. Optional parts may have been done but just barely.	18/20 A-
Does what needs to be done, nothing more. Minor flaws in units, labels, graphs or notations.	**This is good work of good quality.** It was complete and generally accurate; and, though it might contain errors, the point of the assignment is well conceived. This student put an adequate amount of work into the lab and it is evident that s/he learned something from it. Exactly what was asked was completed not much more, not much less. No optional parts were completed.	17/20 B
Completed. Minor flaws and/or confusion in an answer or two.	**This is acceptable work of OK quality.** There are a few errors such as missing units or confused answers. One or two measurements might be wrong. Answers are probably a little lackluster. Graphs are OK but might have minor flaws.	16/20 B-
Several errors in answers. Various flaws and/or sloppiness in notation. Complete	**This is adequate work of average quality.** This lab might have several notable errors in it. It might simply have numerous minor errors. Although the student completing the lab certainly learned something from it, s/he also may have missed some important points. There might be errors in measurements or conceptual errors. Often this score is given to labs where the bare minimum was done or was hurried through with minimal care.	15/20 C
Incomplete Significant Errors Poor Effort	**A below average effort.** This assignment probably has some major flaws. Or, this lab is mostly complete, but it might be missing a major component. This may be due to incorrectly completing the assignment, or just a general lack of effort. This score is usually received by only a small minority of assignments.	13/20 D
Major Problems	**A very poor effort.** This assignment was not completed (0), or did not satisfy enough assignment requirements to receive significant credit.	#12/20 E

PHYS 4410, Advanced Physics Laboratory
Spring Semester
Sample Schedule of Experiments

The actual schedule will depend on the number of students who register, equipment availability, instructor expertise, etc.

Week	Experiment
1. Jan 4	Intro/Static Friction
2. Jan 11	SEM with EDS Chemical Analysis- Mosely's Law
3. Jan 18 *	Environmental SEM
4. Jan 25	SEM with Cathodoluminescence
5. Feb 1	Atomic Force Microscopy I, Contact Mode
6. Feb 8	Atomic Force Microscopy II, Tapping Mode
7. Feb 15*	Magnetic Force Microscopy
8. Feb 22	Mechanical Spectroscopy
9. Mar 1	Solar Cell Characterization
10. Mar 8	Mössbauer Spectroscopy
11. Mar 22 Draft Formal Report	X-Ray Diffraction
12. Mar 29	X-Ray Fluorescence
13. Apr 5 Final Formal Report	Capstone
14. Apr 12	Capstone
15. Apr 19	Final

*Short Week