**PHYS 6350 - INTRODUCTION**

**GOALS AND PHILOSOPHY**

This course is an interesting mixture of old and new curricula. The basis of the course is a laboratory experience in physics. However, to call it purely a laboratory course would not be correct. Much of what we do in Physics 6350 is based on the results of physics education research. We hope to provide the high school physics teacher with tools that can be used directly in the classroom. Therefore, in addition to regular laboratories that we feel are essential in any physics course, we also teach computer technology through the use of software and Internet resources. We will do experiments with probes and computers. We previously used calculators and CBLs, but teachers hate them by and large. More and more high schools are obtaining computers for student laboratory use, and we want to introduce you to their powerful utilization. We also think computers are a great asset for better understanding the physics content. More and more teachers in this program are returning to their schools and obtaining computer systems with probes.

Each participant in Physics 6350 is required to do an *Inservice Project* in the few months following the summer program. We will discuss this in more depth in class. The inservice report forms will be provided.

It is easy to lose sight of the fact that all science is based on experiment, either to test the predictions of theories or to present data that current theories cannot explain in order to spur better theories. Over a period of centuries, millions of researchers have taken painstaking measurements, analyzed the data, and fit the data in theoretical models to give it clarity, meaning, and predictive power. We have no knowledge *a priori* that there should only be three forces (the search is still on for evidence of additional forces and work is in progress to unify the existing forces). There is no way of knowing that the conservation laws should hold everywhere on this planet or across the universe. This knowledge is obtained by careful observation and a self-consistent understanding of these observations.

If you find science difficult, you are not alone. The concepts themselves are often not easy to grasp. Research has shown that we each must construct our own models of understanding. Simply listening to lectures and rote memorization are not good ways to learn. We must be able to assimilate the concepts and apply them to predict further phenomena. Research has also shown that learning improves when a student thinks about a concept or problem by him/herself first and then discusses it with a small group of peers. That is the philosophy we will follow in this course. The abilities to work within a group of peers and to communicate ideas, both orally and in writing, are important skills to have. These are fundamental goals of this course.

We expect that most of you will not have extensive experience in experimental science. We expect to help you learn how to approach measurement and experiment with more confidence. Often the difficulty is to determine just what needs to be measured. Figuring out a way to isolate a particular phenomenon to measure or to test complicates things, because usually changing one parameter may affect several others. Identifying and then minimizing or eliminating systematic and random errors requires great care and patience. Yes, even science can be tedious. The
reward, however, is great: You come away with a rich understanding of the phenomena you are studying and therefore a better understanding of the world around you. You develop important skills as you practice the scientific method. You build confidence in your ability to test and understand the “rules” of nature. Your understanding, the skills you develop, and the confidence you build allow you to identify and tackle problems you have not seen before or for which you have not been specifically trained.

We expect that this course will

1. Teach you some important physical phenomena and concepts.
2. Teach you to think for yourself and to work with groups of peers.
3. Teach you better oral and written communication skills.
4. Introduce you to proper laboratory procedures and teach you some basic laboratory techniques.
5. Give you confidence in your ability to take measurements and adequately analyze and interpret data.
6. Give you ideas and suggestions to use in your own classroom.
7. Give you a better understanding of what it feels like to be a student in a classroom.
8. Give you confidence to have your students perform more laboratory measurements.

COURSE ORGANIZATION

Every student must use the notebook manual provided for Physics 6350. Sometimes we refer to it as a journal. Your work in Physics 6350 will consist of several parts:

1. Doing a prelab activity for the morning and afternoon that you must complete before coming to the workshop. This assignment will be done on the Internet-based service WebAssign.
2. Performing the lab itself, recording your group's work in your notebook, and writing a “reflection” for each lab experiment. Your recorded lab work will be turned in daily for grading. You will not be writing a separate lab report for this lab. Your reflections will be handed in daily.
3. Taking a postlab quiz for each morning and afternoon based on the activities.
4. Taking a final exam.
5. Doing an Inservice Project activity with your peers in the months following the summer work.

PREPARATION

For each lab, you must do the prelab activity that can be found on WebAssign. Each assignment will be available at least one day in advance. The prelab assignments will be available no later than 4 pm the day before the lab and due by 30 min before the lab begins. The prelab assignment has multiple submissions and is meant to be a tool to prepare you to carry out the lab. The postlab quizzes will be available after 3 pm the day of the lab and due by 5 am the next morning. The postlab quiz has a maximum limit of three submissions and must be completed without any assistance. You must submit the entire postlab answers at once; you may not submit only one
answer at a time like is allowed for the prelab assignment. The postlab quiz is timed and has a maximum of 45 minutes to complete. The three submissions for the postlab quiz allow you to submit your answers partway through the 45 minute period. Do not go over the time limit or you will receive a grade of zero. There is no alternative to this. Never, ever start a postlab quiz if you think there is a chance of something like a thunderstorm or an angry roommate shutting off your computer. The WebAssign clock is still ticking!

IT IS YOUR RESPONSIBILITY TO LOOK AT THE WEBASSIGN WEBSITE OFTEN ENOUGH TO BE AWARE OF THE DAILY ASSIGNMENTs, PRELAB ACTIVITIES, AND CHANGES IN THE DAILY LAB.

In order to complete the prelab activities each day, you should do the following:

1. **Read** over the lab material in this manual (including the relevant appendices and outside reading assignments, where appropriate) for the day’s activities completely to obtain an overview.
2. **Read** the instructions *again*, but this time more carefully; highlight the important features of the workshop. Try to work through any derivations you do not understand. In other words, be an *active* reader and *study* the manual.
3. **Complete** the pre-workshop activities.
4. **Keep** linear graph paper in your notebook in case you need it. It should have at least five (5) and preferably ten (10) rulings per centimeter.
5. **Bring** a graphing or other scientific calculator to the lab. In addition to standard mathematical functions (such as exponentiation and trigonometric functions), the calculator should also be capable of performing linear best fits to data. We can lend you a TI-83 if you need it.

Preparing well beforehand will save you time and trouble in the lab, where you may often find yourself under time pressure.

Before attending the lab section on the second day look over the lab manual and become familiar with the appendices to which you should refer as needed throughout the course. Particularly important are Appendix B: Graphical Analysis, Appendix D: The Accuracy of Measurements and Significant Figures, and Appendix E: Vectors. Refer to Appendix D and apply it appropriately in your lab journals throughout the class.

**PROCEDURE IN THE LAB**

You will need to be efficient in the use of your time. Normally you will work in groups of three. You will work in a different group each session (morning and afternoon are separate sessions), and we assign you a particular table each session in a random fashion. We encourage a free exchange of ideas between group members (and also generally in the lab), and we expect you to share in *taking data*. You and your group members will not necessarily receive a common grade for the lab journal because some of it will be individual work and some of it will be done jointly.
THE LAB JOURNAL

The completeness of the lab journal is of the greatest importance. You need to relate to your own students that no matter whether they are a researcher writing a paper about an experiment completed a year ago, a physician studying an old case history, or an engineer going over some earlier test protocol, they will always wish that the notes that they had made at the time were more complete. All the details that were earlier too obvious to be written down will now be forgotten, the abbreviations that were self-evident will now be mysterious, etc. Sometimes the experimental apparatus must be torn down before you can complete a full analysis of your data. It is vital that your results be completed while you still have access to the experiment. Preliminary plots and data analysis in lab give you an opportunity to catch and fix mistakes during the lab. The lab journal prepared in class is the one you must turn in. You are not allowed to rewrite the journal later.

1. Lab Experiments

An essential part of all scientific experiments is a carefully kept record of everything that is done in the laboratory. It should be done in pen (NOT pencil), preferably in blue or black ink (NOT red). Your lab submission should include the following:

- The date and group members’ names.
- Tables of the data as they are taken. Computer produced tables are fine.
- Group figures, plots, and tables are okay.
- Notes on difficulties in taking data and how you circumvented these difficulties.
- Plots of the data, properly labeled and with correct units.
- Results of data fits, including equations and parameter values.
- Data analysis and conclusions (include proper significant figures, random error calculations and systematic error estimates, etc. Do things make sense? How do the results compare with theory?). Usually this will be done by answering questions.
- Observations of unexpected occurrences and effects.
- Answers to all the questions and predictions posed in the manual.

Write down all these things as you go along. All mistakes must be clearly crossed out; they should not be erased or whited out.

2. Worksheets

Sometimes we will have you complete worksheets, and you will be expected to hand those in individually with your journal. Note that often you complete these worksheets together in your group, but we want your sheet to be completed by you!

3. Reflections

Besides being valuable for assessment, journal writing is a powerful catalyst for thinking. Writing does help clarify and organize one's thinking. Writing can even create ideas that did not exist before the writing began. The writing must be done carefully and legibly so the instructor
has no trouble reading it. Journal writing will improve your ability to use scientific words appropriately, to focus attention on the most important concepts, and to increase your recall of generalizations. **Students will be expected to write down their reflections on each morning and afternoon's activities after every lab/workshop.**

We expect that all your reflection writing will be done in lab and turned in daily before leaving. The reflection may include what was learned, what was found surprising, how the information might be useful, and suggestions for improving the experience in laboratory. We will provide you with a reflection sheet that you can use. The reflection sheet may change throughout the course. **THE REFLECTIONS MAY BE PART OF THE LAB GRADE.**

**GRADING POLICY**

Your grade in Physics 6350 will be determined approximately as follows:

- The **Prelab activity** is worth 15%.
- The **Lab Submission** is worth 35% based on the performance in the laboratory as evidenced by our observations, your lab submission (see the discussion above), and your session reflections.
- The **Postlab quizzes** are worth 20%.
- The **Final Exam** is worth 30%.

The **Inservice Project** is required, and you will receive a failing grade in the course if you do not do it. It must be completed by October 1, 2013. You will be provided a short form on which you will describe your inservice project.

We reserve the right to modify this grading policy during the course.

**ABSENCES AND TARDINESS**

Absences and tardiness will be accepted only for legitimate excuses. Without a bona fide reason, all absentees receive a grade of zero for that lab. Late arrival for any lab session is very disruptive and will be penalized. After a 10-minute grace period, the lab instructor will deduct 10% from your journal grade for that session for each 15-minute period that you are tardy. Because of the busy schedule, it will probably not be possible to have make-up labs.