Physics Advanced Lab

Requirements

Short written research proposal

The object of this proposal is to convince your instructor that your project is doable and interesting. No research in the real world gets done without convincing someone (with money) that the project is doable and interesting.

Individual notebooks

All research must be documented. The object is to be able to prove to the world that the research was actually done. This is one of the most critical skills a researcher must have. Without proper documentation it is nearly imposable to later write a paper about the research that has been done. In this class, your individual notebook is the proof that you participated in the research.

Midterm presentations

This presentation is the first of two talks which will give you practice speaking to a group of technical people. The object is to present any preliminary results you have, describe the work you hope to accomplish in the rest of semester, and try to convince a friendly yet skeptical group of people that you know what you are talking about.

Final presentation

This talk should be a polished presentation of your result. Being able to clearly explain your research to others is an imperative skill for all scientists and is a skill which requires practice.

Final report

This report should be written as if you were going to submit a paper to a scientific journal. It should have an introduction that explains why the research is interesting, a results and analysis section that contains the results of the experiment and any modeling done to understand the results, and lastly a conclusion. In writing this document you will rely on your notebooks, which will contain all the little details that you will have forgotten over the period of a few months. It would be best to be working on the final report throughout the semester, as apposed to a mad dash at the end.

Goals

The overall goal of this course is to give you the experience of doing a nearly real research project, which includes design, performance, and analysis of an experiment, and both oral and written presentation of the results. These are all critical elements in the research world for either applied or basic researchers. They are also all skills that require practice.

Grading

Your grade will be based on the sum of the requirements lists. It will not be based on the smoothness of the oral presentation as this is a trait that comes more naturally to some than others. You should be aware that in the real world you will be judged on presentation skills and this course is one of your best opportunities to practice.

Your grade will depend on you being able to prove that you were an active participant in the research project. This proof will come from your documentation of your work in your individual notebooks.
Possible Projects

1. Circuit Modeling Chaos (Dr. Thomas Vojta)
   A system of transistors can be built with inherent instabilities producing a chaotic system to study.

2. Particulate exhaust measurement (Dr. Hagen, Cloud Physics)
   The equipment in cloud physics could be used to do a model measurement of exhaust composition from a model airplane.

3. Surface Diffraction Experiment (Dr. Waddill)
   The equipment in Dr. Waddill’s lab could be used to do surface studies of materials.

4. Graphene
   An attempt to make and study the single atomic layer of graphite.

5. Heat Engine
   Build and make measurement, such as efficiency, of a simple heat engine.

6. River Carving
   Study the dynamics of river evolution on a model system.

7. Interferometer Coherence Measurement of Light
   An interferometer can be used to determine the coherence length of light, which can, for example, tell the difference between laser light and incoherent light.

8. Height Distribution Measurement of Randomly Kicked Ping-pong Balls.
   A thermodynamic model for random motion can be developed to compare with the Boltzmann distribution.

9. Echo Sound Imaging
   Sound can be used to produce an image of the shape of object.

10. Stand Candle Measurement
    The use of standard candles in astronomy can be explored with an actual standard candle.

11. System of Interacting Magnet to Model Spin Systems
    A system of magnets that are allowed to rotate but not translate could be used to model electron spin interactions. (Dr. Parris would be available to help with modeling.)