



14FA_PHY_261_A Research Experience

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Syllabus

Physics 261 Research Experiences in Physics

Fall 2014 Course Syllabus

Instructor: Don Salisbury

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Class Meeting Time: Tue, 8:00-10:50 AM

Office Hours: To be announced

Course Description

These courses are part of a two-course sequence that offers students the opportunity to work in small research groups on independent research projects. Students work closely with a faculty member in the Physics Department on topic selection, theoretical and experimental design, data analysis, and presentation of results. Topics vary depending on student background and interest.

Student Learning Objectives

The physics faculty strongly believes that independent research projects add depth and breadth to students' background beyond traditional coursework. In this two-course sequence, students will

- Work collaboratively with faculty and other students,
- Conduct "authentic" research on contemporary topics,
- Initiate research tasks and attempt to find solutions to problems,
- Design experiments using modern equipment and data analysis techniques,
- Formulate and explore physical models using theoretical, experimental, and computational approaches,
- Synthesize physical concepts and apply them to new situations,
- Read and comprehend papers, in some depth, from scientific journals,
- Write short proposals describing potential scientific research,
- Present scientific results orally to a peer group, similar to the nature and format of scientific meetings,
- Write research papers following standard conventions in scientific journals.

Required Books

Thorne, K., *Black Holes and Time Warps*, W. W. Norton (1995).

Alley, M., *The Craft of Scientific Writing*, 3rd edition, Springer-Verlag, New York, 1996.

Structure of Research Experiences in Physics Courses

Research Experiences in Physics (REP) courses offered by the Physics Department at Austin College are 0.5 credit courses in which students work in small research groups on independent research projects. Normally, sophomores take the introductory course (PHY 261) while juniors and seniors take the advanced course (PHY 361). Physics majors are required to take 2 REP courses, and physics minors are required to take 1 REP course. Students must take the two courses with different instructors to ensure exposure to a variety of research approaches and techniques.

The faculty instructor will suggest a topic that is related to his or her own research endeavors. In most cases the proposed project topic will be related to course material learned from previous semesters. But the REP project often extends exposure to interesting topics only briefly addressed in a typical course.

The research project will consist of work which embraces experimental, theoretical, or computational investigation, or some combination of these methods. The

project will span the entire semester, beginning with the drafting of a research proposal during the first two weeks of class and concluding with submission of a final report during the 13th week of class. Students with especially meritorious projects will be invited to summarize their work on the Departmental web page.

Although students will be working closely with faculty members, it is the students' responsibility to work on the projects. Murphy's Law seems to apply frequently on research projects, so students are encouraged to begin projects early. Failure to meet deadlines will result in an automatic project grade penalty.

Topic Selection: The physics faculty will provide project suggestions during the 1st week of class. Topics to be explored will be related to previous course content.

Weekly Class Meetings: Students will meet during the usual class period for general activities related to research and experimental design as shown in the schedule below. Topics to be covered may include aspects of scientific writing, proposals, oral presentations, citations, hypothesis testing, scientific modeling, and error analysis.

Research Notebook: Students must keep a log of all research activity. Records can be kept either in a bound notebook, or in a loose leaf folder. Dates and page numbers must be clearly labeled. The notebook must include lecture notes, reading notes, calculations, and general ideas on the conduct of the research. The instructor will monitor it each week in class. You are also required to include in this notebook a weekly progress report.

Weekly Time Commitment: You should plan on investing roughly nine high-quality hours per week in this course, including class meeting time.

Project Proposal: By the 3rd week of the term, the class project group will submit to the instructor a two-page proposal that briefly describes a project. Proposal guidelines are described in more detail below.

Project Paper, Draft: A draft of the project paper is due during the 10th week of class. A separate project paper is required from each individual in the class. This policy differs from requirements in the introductory physics courses PHY 111 and PHY 112 in which group papers are submitted. Project report guidelines below specify the required parts of a report.

Presentation: Each student must give an oral presentation during the 12th week of class. Time limits such as those imposed at scientific meetings will be enforced. Preparation for this talk should be taken seriously and will include at least one rehearsal presentation with the supervising faculty member. If possible, all physics faculty will be present for the formal presentations. The course instructor will solicit colleague feedback on each presentation and incorporate these evaluations in the grading process.

Final Project Paper: Final written reports describing the project and results are due during the 13th week of class. A separate final paper is required from each individual in the class. This policy differs from requirements in the introductory physics courses PHY 111 and PHY 112 in which group papers are submitted. The project report guidelines below specify the required parts of a report.

Final Project Meeting: The instructor will meet with each student before the term ends to discuss the work on the project, the oral presentation, and the written report. In addition, students will individually evaluate the contribution of each member in the project group.

Grading Policy

Participation (10%): Students are expected to participate in scheduled course activities. In addition, all course assignments must be completed in a timely manner.

Research and Experimentation (30%): Students will receive credit for proper research techniques, effort, perseverance, innovation, and creativity. A research report that summarizes scientific data, ideas, and progress must be turned in each week.

Research Paper (30%): Guidelines for the research paper are provided below. A first draft is due on Friday, November 14, 5:00 PM. The final draft is due Friday, December 5, 5:00 PM.

Presentation (30%): Guidelines for presentations are provided below. Presentations will be conducted on Tuesday, November 18, 4:30-6:00 PM.

Academic Integrity

A high ethical standard serves as a crucial foundation of scientific advancement. Falsification of data (in pharmaceutical research, for example) could produce disastrous results later. In this course, you will be working in small groups in close collaboration with other students and faculty. We expect students to maintain and uphold the highest standard of scientific integrity.

Plagiarism, falsification, and cheating will not be tolerated and will result in failure of this course.

A recent national survey suggests that college students and faculty have different perspectives on academic integrity and cheating. The following list provides a *partial* list of actions that the Physics Department considers violations of academic integrity in this course:

1. Turning in work done by someone else.
2. Working on an assignment with others when the instructor asked for individual work.
3. Writing or providing a paper for another student.
4. Falsifying lab or research data.
5. Fabricating or falsifying a bibliography.
6. Copying a few sentences of material from a written source without footnoting them in a paper.

7. Turning in a paper either purchased or plagiarized, in large part, from a term paper "mill" or website.
8. Copying a few sentences of material from an Internet source without footnoting them in a paper.
9. Copying material almost word for word from any written source and turning it in as your own work.
10. Turning in a paper copied from another student.
11. Using a false excuse to obtain extension on due date.
12. Hiding or damaging library/course material.
13. Cheating on a written assignment in any other way.

Semester Schedule

Initial Topic Presentation	Tuesday, September 2, 8:00 AM
Proposal writing activity	Tuesday, September 9, 8:00 AM
Project Proposal Due	Friday, September 19, 5:00 PM
Paper writing activity	Tuesday, October 28, 8:00 AM
Presentation activity	Tuesday, November 11, 8:00 AM
First Draft of Paper Due	Friday, November 14, 5:00 PM
Presentation	Tuesday, November 18, 4:30-6:30 PM
Final Paper Due	Friday, December 1, 5 PM
Final Meeting	Tuesday, December 2, 8:00 AM

Bold indicates required meetings during the normally scheduled course time.

Proposal Guidelines

The purpose of the proposal is to clearly define the objectives of the research project. As the research progresses and new ideas develop, you will probably deviate slightly from the original objectives stated in the proposal. Nevertheless, it will provide a good starting point for your research and help you develop the basic framework of your research question. The two-page proposal will be written together by all members of the group. It will be graded. The proposal should include the following:

- o Proposal title, names of group members, date, course name, and course number should appear at the beginning of the proposal.
- o A brief statement of the main purpose of the project should appear next. The scientific question to be addressed and your working hypothesis (what you expect to discover) should be described.
- o An initial plan for conducting the research should be outlined, including a brief discussion of experimental techniques. A project timeline should be included.
- o The proposal will cite a minimum of three references that you consulted in the process of selecting a project topic. These references may be any type of source, *e.g.*, textbook, web site, other reference volumes, or scholarly periodicals, but at least one of the references must be a scholarly periodical. References and citations will use the same format as Alley's textbook. Please refer to Michael Alley's website "Writing Guidelines for Engineering and Science Students" (<http://www.writing.eng.vt.edu>) for additional information on reference format.

Weekly Progress Report Guidelines

The purpose of the weekly reports is to provide an update on your research progress prior to the weekly class meeting. It should contain the following sections:

- o *Highlights and Accomplishments.* Please include brief yet appropriate details on instrumentation, techniques, theoretical understanding, nice results, and new scientific connections. This is the section where you get to discuss what went well.
- o *New Issues and Concerns.* Discuss what was tricky for you this week and what you would do differently. Please address any major issues and how you plan to solve them.
- o *Priorities for Next Week.* Describe your plans for the next week and how it fits into your overall research schedule.

Research Paper Guidelines

Each research paper must be word-processed (including equations) using any word processor with which you are comfortable. Data, images, and graphs should be included within the body of the report, not appended at the end, and should be properly identified in a caption. Diagrams in the final draft of your paper must be made with computer drawing programs, but the required first draft can contain hand-drawn diagrams. The total length of the paper will depend on the nature of the project, but will typically be 8-10 pages in length. The project report must contain the following sections:

- o *Title Page:* The title page should include the project title, your name, and names of your partners, date, course name, and course number. In addition, it should

contain an abstract that summarizes the important points and results of your project. You may want to complete all other parts of your report before writing the abstract.

- *Introduction*: This section should provide a context in which the main objectives of the paper can be understood. Background information and previous research should be discussed here. This section should contain a clear, concise statement of the main purpose of the project. The introduction should be 2-3 pages in length.
- *Theoretical and Experimental Approach*: Discussion of theoretical foundations with equations should be included here. A listing of equations will not suffice. Instead, theory should be placed in context. If key equations used in calculations are not derived in your text, they should be derived in this section of the report. You may want to look up and cite some references that provide you with some added theoretical grounding for the project. For experimental projects, a description of procedures and equipment used should be included in this section. An apparatus drawing with appropriate labels would be appropriate in this section. For computational projects, the numerical approach and computer program structure should be outlined.
- *Results*: Data should be clearly labeled with units. Calculations and data analysis with calculated uncertainties should appear. Each calculated step should be displayed for at least one sample calculation of each type (including equations used to calculate each column in a spreadsheet). Results may be displayed in tabular or graphic form with axes labeled with units. Digital images may also be used. This section should *not* contain every single detail, result, and analysis of your experiment. Rather, it should highlight the most important aspects of your research by providing supporting (or non-supporting) evidence of your main thesis. For example, multiple pages of numerical data do not provide significant insight on the research. A simple plot containing much of the same information as the numerical data (along with a clear explanation of the importance of the plot) would be more valuable to the reader.
- *Discussion*: A discussion of results and conclusions including an assessment of uncertainties and suggestions for improvement of the experiment should appear in this section.
- *References*: A list of references should appear at the end of the paper. Proper citation of these sources should occur in the main body of the paper. Although various journals cite references differently, we will utilize a standard citation format used in the Alley textbook. Additional information can be found on Michael Alley's web site <http://www.writing.eng.vt.edu/>

Alley's book is a good source for an extended discussion of these elements of a report. This resource divides research papers into the following parts: Summary (our *Title Page*), Beginning (our *Introduction* section), Middle (our *Approach* and *Results* sections), and Ending (our *Discussion* and *References* sections). Furthermore, this book offers suggestions on how to organize your ideas and how to write clearly and effectively.

Oral Presentation Guidelines

The oral presentation is a group effort. As such, it is important that you plan in advance who will discuss each section of the presentation. The audience will be your fellow classmates, so you can assume they have a basic understanding of the material at the level covered in the previous course. However, do not assume too much from your audience or they might not understand your presentation. The presentation should be 10 minutes in length, followed by a 2-minute question and answer session. This is not a lot of time, so you should plan accordingly. Each person is required to give a portion of the presentation, so you need to rehearse together at least once. At the end of 8 minutes, you will be given a signal that you have only two minutes left.

In general, you are *not* allowed to bring out the experimental set-up to demonstrate; we would like you to describe it instead. Although your presentation might not contain all of the elements listed below (or it may contain some that are not mentioned), here are some common features of typical project presentations:


- Title Page with investigator names.
- Outline of the presentation.
- Brief Statement of the purpose of the project. Remember, no one knows what you have done for your project.
- Description of the investigation, along with background information, if appropriate. The procedure used to obtain data should be stated along with any diagrams or figures, if this is helpful.
- Data (with uncertainties) should be presented in tables and/or graphs that include units.
- Conclusions based on analysis of the data. This is important!! What do the data tell you? You should interpret, not speculate.
- Discussion of the results. Do your results make sense? What are the uncertainties and what do they imply? What kinds of difficulties did you run into? How might the project be improved?
- Brief conclusion of the project.

Please keep in mind that 10 minutes go by very fast. You may not be able to discuss every aspect of your project in the time allotted. Therefore, you may need to leave out portions that are not critical to understanding the project.

Additional information on preparing presentations can be found in Alley's book.

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 Moodle Docs for this page

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