Syllabus

Physics 361 Research Experiences in Physics
Fall 2017 Course Syllabus

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Class Meeting Time: Th 1:30-4:30 pm

Office Hours: To be announced

Course Description

This course is part of a two-course sequence that offers students the opportunity to work together on a research project under fac supervision. The topic selection will vary from semester to semester, and may involve theoretical analysis, experimental design, data an and/or computer simulation. Results will be presented orally and in written form.

Student Learning Objectives

The physics faculty strongly believes that research projects add depth and breadth to students' background beyond traditional coursewor this two-course sequence, you 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

Alley, M., *The Craft of Scientific Writing*, 3rd edition, Springer-Verlag, New York, 1996.
Kennefick, D., *Traveling at the Speed of Thought,* Princeton University Press, 2007

Structure of Research Experiences in Physics Courses

Research Experiences in Physics (REP) courses offered by the Physics Department at Austin College are 0.50 credit courses. Normally, sophomores take the introductory course (PHY 261) while juniors and seniors take the advanced courses (PHY 361). Physics majors are required to take two REP courses, and physics minors are required to take one REP course. A single faculty member in the department each course. Students conduct research with two different professors for the two REP courses to ensure exposure to a variety of researcl approaches and techniques.

Students work collaboratively in groups on a research project that spans the entire semester. The project will embrace experimental, the and/or computational methods as appropriate. Since communication of scientific research is a vital part of the scientific process, studen give oral presentations in the 12th week of class and submit a final written paper during the 13th week. Each REP course counts as a 1/2 credit toward graduation.

Throughout the semester, classroom activities introduce important aspects of the research process. PHY 261 activities usually address w research proposals, giving oral presentations, and writing research papers. PHY 361 activities may tackle more refined issues such as cr reading of science papers, finding relevant peer-reviewed articles, and error analysis. In addition, activities associated with Austin Colle

STEM Teaching And Research (STAR) Leadership program on interpersonal communication, collaborative learning, and foresight/plan
occur throughout the semester.

Roles and Responsibilities

You are expected to take an active role in your learning. Your responsibilities include:

- *Active Engagement*: You should be prepared to participate fully during all meeting times. You will meet during the usual class peri general activities (see above) and to make progress on your research topic.
- *Initiative*: You should take ownership of your learning. Although students will be working closely with the faculty member, it is th students' responsibility to work on the projects. Do not wait for the instructor to tell you what to do - develop your own ideas and p them. Roughly half of the work on the project will occur under the supervision of the faculty member during the regularly schedul weekly class time.
- *Teamwork*: You will be working collaboratively with other students. You are expected to facilitate a supportive team environment, including positive reinforcement and constructive conflict resolution.
- *Creativity:* You will be addressing research problems for which there are no known solutions. You will need to approach these pro creatively and from multiple perspectives.
- *Reflection*: Students will submit to their faculty supervisor a **Weekly Report by Wednesday, 5 PM.** The one-page report will refle research progress during the previous week. Reports will be submitted via Google Drive. Specific guidelines for the reports are pr below.
- *Commitment*: You should plan on investing roughly six high-quality hours per week in this course, including class meeting time.
- *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 collabora 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.

Faculty responsibilities include:

- *Topic Selection*: The precise topic is related to the faculty member's area of research expertise.
- *Collaborative Research Guidance*: We are in this adventure together! This research is collaborative - you will be working as a tean the instructor. The instructor will help provide the necessary tools for students to do research, as well as provide activities to help students master the research process. The instructor will also make decisions regarding the overall direction of the research, as nee
- *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.

Course Requirements and Grading

- *Participation (10%)*: Students are expected to participate in scheduled course activities and weekly meetings with the research advisor. In addition, all course assignments must be completed in a timely manner. See Roles and Responsibilities above.
- *Research and Experimentation (30%)*: Students will receive credit for proper research techniques, effort, perseverance, innovation, creativity. A research proposal (described below) is part of this grade. Your research should be documented in a research noteboo addition, a weekly 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.
- *Presentation (30%):* Guidelines for presentations are provided below.

Important Dates

September 7	Submit Research Proposal
November 2	Submit Research Paper
November 14	Present Results to Wider Audience (4:30 pm)
November 30	Submit Final Research Paper

Accommodations

If you anticipate accessibility issues related to the format or requirements of the course, please meet with the instructor so that we can di solutions. Austin College seeks to provide reasonable accommodations for all individuals with disabilities and will comply with all appl federal, state, and local laws, regulations, and guidelines. It is the responsibility of the student to register with and provide verification o academic accommodation needs to the Director of the Academic Skills Center as soon as possible. The student also must contact the ins a timely manner to arrange for reasonable academic accommodations. For further assistance, please contact the office at 903-813-2454 o the Academic Skills Center.

Changes to the Course

The instructor reserves the right to modify course requirements and course schedule, if such changes will provide a better learning exper the students.

Safety and Equipment Use

You may be using state-of-the-art equipment in the laboratory and in the field. Safety is of the utmost importance. Below are some gene guidelines to follow:

- Conduct yourself in a responsible manner at all times.
- Pay attention and be aware.
- Dress appropriately for laboratory work and field work.
- Know the location of safety equipment in the room (fire extinguishers, eye wash, fume hood, etc.)
- Do not eat or drink in the laboratory.
- Maintain a clean environment and remove all obstacles from your work area.
- Treat all equipment with care and respect.
- Treat all participants with care and respect.
- Inform the instructor immediately if equipment is damaged or is not working properly.
- Inform the instructor immediately if you are damaged.

Research Notebook Guidelines

The research notebook records the progress of your scientific project from initial ideas to final conclusions. Think of it as your scientific documents the day-to-day work: reading notes, questions, hypotheses, equipment, techniques, results, new ideas, successes, failures, and conclusions. The research notebook proves that the work was completed on a certain date and is considered a legal document. Research notebooks have provided valuable evidence in patent law cases.

Each scientific project will have slightly different guidelines for what should be recorded in the research notebook. Specific guidelines a format will be provided.

Weekly Report Guidelines

The weekly report is a separate entry in your research notebook. Here you will summarize and reflect on work recorded in your research notebook. The purpose of the weekly report is to provide an update on your research progress prior to your weekly meeting with your supervisor. It should be roughly one page long and contain the following sections:

- *Highlights and Accomplishments*. Please include brief yet appropriate details on instrumentation, techniques, theoretical understan nice results, and new scientific connections. This is the section where you get to discuss what went well.
- *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.
- *Priorities for Next Week*. Describe your plans for the next week and how it fits into your overall research schedule.

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 will probably deviate slightly from the original objectives stated in the proposal. Nevertheless, it will provide a good starting point for y research and help you develop the basic framework of your research question. The two-page proposal will be written together by all me the group. It will be graded. The proposal should include the following:

- Proposal title, names of group members, date, course name, and course number should appear at the beginning of the proposal.
- 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.
- An initial plan for conducting the research should be outlined, including a brief discussion of experimental techniques. A project timeline should be included.
- The proposal will cite a minimum of three references that you consulted in the process of selecting a project topic. These reference be any type of source, *e.g.*, textbook, web site, other reference volumes, or scholarly periodicals, but at least one of the references m be a scholarly periodical. References and citations will use the same format as Alley's textbook. Please refer to Michael Alley's we "Writing Guidelines for Engineering and Science Students" (http://www.craftofscientificwriting.com) for additional information on

reference format.

Research Paper Guidelines

Each research paper must be word-processed (including equations) using any word processor with which you are comfortable. Data, im
and graphs should be included within the body of the report, not appended at the end, and should be properly identified in a caption. Dia
the final draft of your paper must be made with computer drawing programs, but the required first draft can contain hand-drawn diagram
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 cont
following sections:

- *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 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 pur 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 o equations will not suffice. Instead, theory should be placed in context. If key equations used in calculations are not derived in your 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 a theoretical grounding for the project. For experimental projects, a description of procedures and equipment used should be include 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. Eac calculated step should be displayed for at least one sample calculation of each type (including equations used to calculate each colu a spreadsheet). Results may be displayed in tabular or graphic form with axes labeled with units. Digital images may also be used section should *not* contain every single detail, result, and analysis of your experiment. Rather, it should highlight the most importa 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 th 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 bo 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.craftofscientificwriting.com/

Alley's book is a good source for an extended discussion of these elements of a report. This resource divides research papers into the foll
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 cl
effectively.

Although students will be working in a group on the project, a separate project paper is required from each individual within the group.
policy differs from requirements in the introductory physics courses PHY 111 and PHY 112 in which group papers are submitted.

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 presentatio
audience will be your fellow classmates, so you can assume they have a basic understanding of the material at the level covered in the pr
course. However, do not assume too much from your audience or they might not understand your presentation. The presentation should
minutes in length, followed by a 5-minute question and answer session. This is not a lot of time, so you should plan accordingly. Each
required to give a portion of the presentation.

In general, you are *not* allowed to bring out the experimental set-up to demonstrate; we would like you to describe it instead. Although
presentation might not contain all of the elements listed below (or it may contain some that are not mentioned), here are some common f
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 st 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 difficult you run into? How might the project be improved?
- Brief conclusion of the project.

Please keep in mind that 20 minutes go by very fast. You may not be able to discuss every aspect of your project in the time allotted. T you may need to leave out portions that are not critical to understanding the project.

Preparation for this talk should be taken seriously and will include at least one rehearsal presentation with the supervising faculty memb possible, all physics faculty will be present for the formal presentations. Students will assess presentations by other research groups thro peer review process. The course instructor will solicit colleague feedback on each presentation and incorporate these evaluations in the process.

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