# West Chester University Department of Physics Physics 310 – Intermediate Lab I

Meeting Times:	MWF 3:00 - 5:45 pm
Meeting Place:	Merion Science Center 109
Instructor:	Jeffrey J. Sudol (Dr. Jeff)
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<b>Office Hours:</b>	MWF 1-2, TR 2-3

#### **Course Description**

During the Physics 310-320 sequence, you will conduct several of the classic experiments from the  $19^{th}$  and  $20^{th}$  centuries designed to measure the fundamental constants of nature, such as the Universal Gravitational Constant, the speed of light, the charge of the electron, and Planck's constant. These experiments lie at the heart of modern physics, and the structure of the Universe depends critically on the values of these constants.

## **Required Course Materials**

- ✓ An Introduction to Error Analysis,  $2^{nd}$  edition, Taylor.
- ✓ A laboratory notebook.
- $\checkmark$  A scientific calculator.

#### **Attendance Policy**

Attendance is required.

### Website

This course has a D2L website associated with it. I will post all course documents and announcements on the D2L website. Please check D2L frequently.

## **Course Goals**

Physics 310 is an approved Writing Emphasis course in the WCU General Education program. It is designed to help students meet the following General Education goals: (1) students will be able to communicate effectively, (2) students will be able to employ quantitative concepts and mathematical methods, and (3) students will be able to think critically and analytically.

In more discipline specific terms, this course is designed to meet the following goals.

- 1. The student will become adept at using a wide range of experimental tools and measurement techniques common to the modern physics laboratory.
- 2. The student will become adept at using a wide range of statistical tools to estimate and calculate uncertainties.
- 3. The student will advance his or her ability to communicate the design of an experiment and the results of that experiment to an audience of physicists in writing through formal research style papers and in person through research talks.

## The Experiments

During the semester, your must conduct four experiments and document those experiments in a laboratory notebook. You must write and submit research papers for three of those experiments, and prepare a research presentation for the fourth experiment.

The Department of Physics has purchased the equipment required to perform the experiments listed below. You are free to choose three experiments from the list below. I will assign a fourth experiment, at random, to each student.

## <u>PHY 310</u>

The Speed of Light, *c* The Charge-to-Mass Ratio of the Electron, *e/m* The Wavelength of Helium-Neon Laser Light The Fundamental Unit of Electric Charge, *e* Planck's Constant, *h* The Magnetic Permeability of Free Space,  $\mu_0$ The Stefan-Boltzmann Law and Stefan-Boltzmann's constant,  $\sigma$ The Universal Gravitational Constant, *G* The Half-life of a Radionuclide<sup>1</sup>

<sup>1</sup>This experiment requires training in the safe handling of radioactive materials.

#### <u>PHY 320</u>

Electron Spin Resonance Interatomic Distances Avagadro's Number Nuclear Magnetic Resonance Spectra The Hall Effect The Zeeman Effect The Franck-Hertz Experiment Nuclear Spectroscopy of Materials<sup>1</sup> The Index of Refraction of Air<sup>2</sup>

<sup>1</sup>This experiment requires training in the safe handling of radioactive materials. <sup>2</sup>This experiment requires an excel spreadsheet maintained by Dr. Sudol.

#### The Laboratory Notebook

You will maintain a laboratory notebook during this course as you did in PHY 170 and 180. Your laboratory notebook will serve as the foundation on which your formal reports and presentations are built. I am operating under the assumption that you know how to document an experiment in a laboratory notebook from previous course work. If you are not confident in your skills in this area, please discuss the matter with me as soon as possible.

#### Laboratory Practices and Data Analysis

I will conduct three "laboratory practices and data analysis sessions" during the semester (see the **Course Schedule** below).

The PHY 310 laboratory experience differs from your PHY 170 and PHY 180 laboratory experiences in the following ways.

You are on your own recognizance to conduct experiments in the laboratory space dedicated to this course (MER 114 and MER 116). In other words, you set your own schedule, except with regard to the deadlines for papers and the presentation.

You must develop your own procedures for conducting each experiment and analyzing the data.

You must make arrangements with the other students in the class so that no conflicts occur with regard to the use of the equipment or the laboratory space. You must keep the laboratory space in good working order at all times. You must return all equipment to storage after completing an experiment.

You must avoid creating safety hazards. If, at any time, I find that an apparatus presents a safety hazard, I will lock everyone out of the laboratory until the person who created the hazard removes it.

This arrangement is designed to encourage you to engage in professional conduct. In general, in the sciences, laboratory facilities and laboratory equipment are shared due to their high cost. Consequently, coordination and cooperation are critical to everyone's success.

In the interest of lab safety, you must work with at least one other student on all experiments. In the interest of equal participation, however, you may not work in groups of more than three students.

On occasion, equipment will break. You should always think ahead and do your best to prevent damage to equipment, but accidents do happen and things do fall apart. If something breaks, or you break something, make a record of what happened. We can all learn from the experience. Moreover, other students need all of the equipment in the lab to be in proper working order to conduct their experiments, so we must replace or repair broken equipment promptly. Forms are available on D2L to order replacement parts, repairs to equipment, or depleted supplies.

## **Research Papers**

The research papers that you submit must conform to the standards of research publications in physics and astronomy. The *American Institute of Physics Style Manual* will serve as our primary source for these standards. If the AIP manual does not address a particular issue, consult the instructions for authors for *The Astrophysical Journal*, found at the following URL:

http://aas.org/authors/manuscript-preparation-aj-apj-author-instructions.

I will hold three "writing sessions" during which we will review, discuss, and make revisions to writing samples (see the **Course Schedule** below).

## Draft Review

I will meet with each of you, individually, for 30 minutes to comment on each of your papers before you submit a final draft. Please bring two copies of your paper to these draft review meetings, one for me to read and one for you on which to take notes.

Unfortunately, the phrase "draft review" is a bit misleading. Don't be misled. During draft review you must submit what you intend to be the final draft of the paper. Failure to present a complete draft will result in the loss of an entire letter grade on the final draft of the paper.

#### Final Draft

The final draft of each paper is due one week after we meet for draft review. I will dedicate one hour to writing comments on your final draft to help you improve your writing. My expectations for the quality of your work will increase as the semester progresses, so you must take my comments into consideration before conducting the next experiment and writing the next paper.

#### **Research Presentations**

Toward the end of the semester, you will give a talk describing one of your experiments and its result to an audience of your peers and professional scientists, notably, the faculty in the Department of Physics. The experiment on which you give the talk must be different from one of the three for which you wrote a paper. Your talk is limited to 15 minutes in a 20 minute time slot, leaving 5 minutes for questions. Members of the audience may interrupt you at any time during the presentation to ask questions. The faculty and I will provide written feedback on your presentation afterwards.

I will hold one "presentation session" during which I will give a research presentation and afterwards we will discuss its salient features (see the **Course Schedule** below).

#### Assessment

Your "grade" in this course will be based on your performance in the following categories of assessment with the following weights.

- (3) Research Papers ..... 15%, 25%, 35%
- (1) Research Presentation ...... 25%

I will assign each paper and presentation a letter grade of A, B, C, D, or F, based on my professional judgment.

I reserve the right to introduce different forms of assessment as needed and to alter the weight of each of the categories of assessment in the event of some unforeseen circumstance.

Note that I am not the sole judge of your performance. During the research presentations, other faculty in the department will evaluate your work and submit their evaluations to me for consideration.

### Misconceptions

- 1. Most students harbor the misconception that reading and writing are independent of one another. This misconception arises from two general truths (i) reading is a "passive" activity while writing is "active" and (ii) practice makes perfect. So, it might not make sense at first that "practicing" reading makes you a better writer, but reading and writing correlate quite well with one another. The best authors tend to be the most voracious readers. While reading text within a discipline, you learn how words relate to one another, their juxtaposition and relative meaning, the context in which those words are used, and the structure of a language within a discipline.
- 2. Most students harbor the misconception that writing is a universal skill. The truth is that poetry, short stories, novels, technical manuals, legal documents, and scientific research papers, to name a few, require different skill sets. Grammar is universal; "writing" is not. Keep in mind that short stories and novels represent "narrative," whereas scientific journal articles represent "exposition." These two modes of writing are quite different from one another.
- 3. Most students harbor the misconception that scientists spend most of their time "doing science" in a lab. This is far from the truth. Scientists spend most of their time preparing to conduct an experiment, documenting the experiment while it is in progress, analyzing the data from the experiment, and communicating the results of the experiment to the scientific community. Nearly all of this work is "bookish," requiring a lot of reading and writing. Most of the experiments that you will conduct in this course require no more than 30 minutes of active attention to the experiment to collect data, some, as little as 10 minutes. The complete cycle, from the time you decide to do a particular experiment to the time you submit the final paper reporting on the experiment, will require 20 hours on average.

## **Email Policy**

Per the Undergraduate Catalog, you are required to activate and maintain the email account created for you by West Chester University. I will not use any other email account to communicate with you.

## **Disability Statement**

If you require special accommodations because of a disability, please meet with me as soon as possible to discuss your needs. Supporting documentation from the <u>Office of</u> <u>Services for Students with Disabilities</u> (OSSD) is required. For more information regarding this policy, click here: <u>Undergraduate Catalog: Services for Students with</u> <u>Disabilities</u>.

#### **Policy Regarding Grade Assignments**

Grade assignments are final and cannot be changed once submitted at the end of the semester, unless a clerical or computational error is discovered. "No Grade" assignments are made only under extraordinary circumstances. Credit by Examination is not available for this course. For more information, click here: <u>Undergraduate</u> <u>Catalog: Grade Changes</u>.

#### **Academic Integrity Statement**

If you commit a violation of academic integrity, you will receive zero credit for the entire course. This is not negotiable. For more information regarding violations of academic integrity, click here: <u>Undergraduate Catalog: Academic Integrity Policy</u>.

#### **Student Code of Conduct**

I will dismiss students from class for any violation of the Student Code of Conduct and initiate the disciplinary action appropriate to the violation. For more information regarding violations of the student code of conduct, click here: <u>Student Code of Conduct</u>, and here: <u>Undergraduate Catalog</u>: <u>Disruptive Classroom Behavior</u>.

#### **University Sanctioned Events**

If you will be participating in a University sanctioned event that occurs at the same time as an exam (the exam dates on the **Course Schedule** will not change), you must notify me one week prior to the exam. Documentation supporting your participation in this event is required. We will then make arrangements for you to take the exam at a later date or at the scheduled exam time through a proctor.For more information on University Sanctioned Events, click here: <u>Undergraduate Catalog</u>: <u>University Sanctioned Events</u>.

#### **Intellectual Property Statement**

All of the course materials, including the PowerPoint lectures and exams, are the intellectual property of the instructor or another author. Your use of these materials is restricted to your own studies for the duration of this course. It is a violation of Federal Law for you to distribute copies of these materials to anyone in any format at any time.

#### **Electronic Equipment in the Classroom (Unplug)**

Except for calculators, I do not permit the use of cell phones, cameras, voice recorders, computers, or similar electronic equipment in the classroom unless you need to use such a device to accommodate for a disability, in which case you should schedule a meeting with me to discuss the proper use of the device and the data obtained with that device as soon as possible. The spirit of the rule is that the classroom should be an electronic free zone where we tune out the distractions of the world and focus on learning physics. The classroom is a place of dialogue, and the electronic gadgets of our modern culture are not necessary for that dialogue to take place.

## **Course Schedule**

Note: We will set meeting times for draft review and due dates for papers during the first class session.

Date	Lecture Activities
Aug. 27	Laboratory Practices and Data Analysis Session #1:
	The Measure of Uncertainty
Sep. 03	Writing Session #1
Sep. 10	Laboratory Practices and Data Analysis Session #2:
	Chauvenet's Criterion, The Central Limit Theorem
Sep. 17	Writing Session #2
Sep. 24	Laboratory Practices and Data Analysis Session #3:
	Error Bars, Modeling Data
Oct. 01	Writing Session #3
Oct. 08	Presentation Session
Oct. 15	No Class
Oct. 22	Student Presentations
Oct. 29	Student Presentations
Nov. 05	Student Presentations
Nov. 12	Student Presentations
Nov. 19	Student Presentations
Nov. 26	No Class
Dec. 03	No Class