Physics 310, Fall 2018, Course Syllabus

Instructor: Dr. Matthew M. Waite, Merion Science Center 133, ext: 2573, mwaite@wcupa.edu

Class Meeting: W 3-6 pm
Office Hours: MWF 9-9:45 am, MTWF 11-11:50 am or by appointment.

Course Web Page: D2L
Course information can be found here throughout the semester. D2L should be your first access point. If required, links to other sites will be posted on D2L. The syllabus, homework problem solutions, and other interesting links and resources can be found here. Check it regularly!!

Course Goals & Student Outcomes:
During the Physics 310-320 sequence, you will conduct several of the classic experiments from the 19th and 20th centuries designed to measure the fundamental constants of nature, such as the universal gravitational constant (G), the speed of light (c), the charge of the electron (e), and Planck's constant (h). These experiments lie at the heart of modern physics, and the structure of the Universe depends critically on the values of these constants. Through these experiments, you will learn how to work with a wide range of scientific instruments, how to acquire research quality data, and how to analyze such data. Using these experiments as source material, you will also learn how to write scientific papers and prepare and deliver scientific presentations, consistent with the concepts of transparency, reproducibility, and credibility, and consistent with the standards and conventions of the scientific community.

Physics 310 is an approved Writing Emphasis course in the WCU General Education program. The writing sessions, laboratory practices and data analysis sessions, draft review meetings, and presentation sessions that take place during the semester, as well as the feedback that the instructor and other faculty give you on your papers and presentations, are all designed to help you 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 discipline-specific terms, this course is designed to meet the following goals.

1. The student will become proficient at using a wide range of experimental tools and measurement techniques common in the modern physics research laboratory.
2. The student will become proficient at estimating and calculating uncertainties.
3. The student will become proficient at communicating the design of an experiment and the results of that experiment to an audience of physicists in writing through research-style papers and in person through research-style talks.

Attendance: You are expected to attend every class period.

The Experiments: During the semester, you must conduct four experiments and document those experiments in a laboratory notebook. You must write and submit "research papers" on two of those experiments, a group poster presentation on the third and prepare a solo "research presentation" on the fourth.

The Department of Physics has purchased the equipment required to perform the experiments listed below. (The PHY 320 list is provided for context.)

PHY 310
Planck's Constant (The Photoelectric Effect)
The Half-life of a Radionuclide
The Wavelength of a Laser Diode
The Charge-to-Mass Ratio of the Electron
The Quantization of Atomic Energy States (The Franck-Hertz Experiment) Avagadro's Number
The Speed of Light (distance-velocity-time method)
The Fundamental Unit of Electric Charge (The Millikan Oil Drop Experiment)
The Universal Gravitational Constant (The Cavendish Experiment)

PHY 320
The Fundamental Unit of Electric Charge (The Millikan Oil Drop Experiment)
The Universal Gravitational Constant (The Cavendish Experiment)
The Speed of Light (Foucault's Method)
The Speed of Light (Ole Roemer's Method)
Electron Spin Resonance
The Hall Effect
The Zeeman Effect
Nuclear Spectroscopy of Materials

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1 This experiment requires training in the safe handling of radioactive materials.

2 These experiments may only be done for presentation (no papers).

3 These experiments may only be done for presentation (no papers).

4 This experiment requires training in the use of a telescope to time the emersion of Io from eclipse and can only be completed when Jupiter is available in the night sky.

5 This experiment requires successful completion of the half-life experiment as a pre-requisite.
The Index of Refraction of Air
The Sodium Doublet
The Mass of the Neutron

**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 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 presentations.

You are on your own to assemble the apparatus to conduct an experiment.

You must develop your own procedures for conducting an experiment and analyzing the data. Although such procedures are often provided in equipment manuals, those procedures are often flawed or designed for instructional purposes. Your must develop procedures appropriate for a research laboratory environment, not an instructional laboratory environment.

You must make arrangements with the other students in the class with regard to the use of the equipment and the laboratory space so that no conflicts occur. You must keep the laboratory space in good working order at all times.

You must avoid creating safety hazards. If, at any time, I find a safety hazard, I will take into possession all of the equipment associated with that hazard, thus disrupting your experiment. I will release the equipment after we meet to discuss the nature of the hazard and how to avoid it in the future.

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, cooperation, and consideration are critical to everyone's success.

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*This experiment requires use of an excel spreadsheet for calculating the index of refraction of air available from the instructor.*
In the interest of lab safety, you must work with at least one other student on all experiments. You are at NO TIME to be conducting any part of the experiment by yourself. Of course, writing and presentation preparation are all done by yourself, but the data collection and equipment set up, etc. are all done with your lab partner. In the interest of equal participation, however, you may not work in groups of more than three students.

Finally, take note that all of the experiments "work". That is, when all of the equipment is calibrated and when the experiment is executed properly, the experiment produces a result that is consistent with results published in the professional literature. I performed each of the experiments in the month of August and found them all to be in excellent working order, obtaining very satisfactory results. If the value that you obtain for a fundamental constant is not in agreement with (or consistent with) values published in the professional literature, you must take the following actions to discover what error has occurred and fix it. (1) Where possible, calibrate the equipment and make sure it is working properly (which you should have done before doing the experiment). (2) Check the equipment for defects and damage (which you should have done before doing the experiment). (3) Consult a faculty member regarding the procedure or the data analysis. (4) Ask me to check the equipment. Do not disassemble or attempt to repair equipment. Leave that to me. A paper or presentation in which the result is not in agreement with the literature will not receive a particular high score. Troubleshooting may take many hours, so it behooves you to plan far ahead and take good notes.

Bear in mind that professional scientists have no reference values against which to compare their results, but they do have extensive experience conducting experiments, and they execute their experiments with great care. In this class, you will be acquiring the kind of experience that allows you to execute experiments with great care, and one final component of that experience involves comparing the results of your experiments to well established values in the literature. As you do the experiment, proceed as if you do not know this well established value (e or h or c, etc.) Because you know "the answer", you might be tempted to commit all kinds of terrible crimes against the data. You must be extremely careful not to introduce any bias in your work because you know the answer. Stay honest. I'm here to help when you get stuck.

**Caring for Equipment:**
The equipment that you will use to conduct experiments during this course is quite expensive. The total cost for all of the equipment in the lab exceeds $250,000. Single items can be quite expensive, too. For example, the Fabry-Perot etalon costs $3,500, and the x-ray diffractometer costs $22,000.

**Food and Drink are expressly prohibited in MER 114 and MER 116.**
Upon the first offense, your access privileges to MER 114 and 116 will be revoked, and you must see me to gain access to the lab each time you want to enter the lab.

Despite the high cost of the equipment, caring for the equipment requires no special training other than care, respect and attention. Simply put, plan ahead. All of the manuals for the equipment in the lab are available on D2L, and all of the manuals describe how to handle the equipment safely. I expect you to read the manual for each piece of equipment from cover to cover before using the equipment. (The colloquial notion that "nobody reads the manual" is a myth. Read the manual!) Familiarize yourself with the equipment before using it. Create a "script" of all of the actions that you are going to execute during an experiment before you execute them. (This should be included in your lab notebook for easy reference!) Review that script. Think about all of the ways you might harm the equipment before you take any action. When you are confident that your actions will not harm the equipment, then proceed with the script.

**Equipment Release-Return Program:**
To hold you accountable for taking good care of the equipment, the following policies are in effect.

1. All of the equipment cabinets in the labs are locked. A complete inventory of the equipment necessary for each experiment is available on D2L. You need to see me to gain access to the cabinets when I have seen your script and you and I agree that you are ready to proceed.

2. I will be available during my office hours, and perhaps other times, to release equipment and take equipment in return. I occasionally have other classes to teach, meetings to attend, naps to take, etc. and might not be available at your whim. Plan accordingly.

3. You must submit an "Equipment Request" to me when you arrive to take possession of equipment. The Equipment Request form is available on D2L. If someone else has submitted a request for the same equipment ahead of you, or if someone else is in possession of the equipment, I will not be able to release the equipment to you. You must communicate your equipment needs to your fellow students so that no conflicts occur (see Laboratory Practices above). Please pay careful attention to the tag numbers on the equipment. For example, we have several lasers. Each has a different tag number. Do not default to requesting laser #1 each time you make a request for a laser. Determine which lasers are actually in use and choose one accordingly. (You will also find that the laser that works best for a particular experiment lies in close proximity to the rest of the equipment for that experiment on the inventory sheet.)

4. You may not take possession of more equipment than is required to run one experiment at a time.
5. There will be stiff penalties for using equipment that (1) has not been released to you, (2) is not part of the equipment inventory, or (3) has not been sanctioned for use in the lab by your instructor.

6. Equipment transfers between groups are not allowed. When you are done with the experiment, you turn it back in. (you don’t want to give it to another lab group and find that they break it while it is checked out under your name!)

7. You have three hours after receiving any piece of equipment to check that equipment for damage and report any problems.

8. You may not hold equipment for more than three weeks. At the end of three weeks, I will return the equipment to inventory, and I will not release that equipment to you again.

9. Penalties for damaged equipment are assessed as follows. Whenever a piece of equipment is damaged, the reason for the damage will be assessed by your instructor and the department chair. We will determine the penalty based upon our findings.

Research Papers:
Although you are not writing the paper to be published in a scientific journal, your paper should have the look and feel of a professional paper (as described below). You are not writing the paper for physics majors or humanities majors or professional scientists. You are writing the paper for scientists (physics majors/minors and faculty). By way of summary, the mark of a good, scientific paper is transparency. The mark of a good experiment is reproducibility, and a good scientific paper is sufficiently transparent to allow the reader to reproduce the experiment and its result. Furthermore, in a good, scientific paper, the author builds credibility with the reader. The fundamental goal of this course is to provide you with the experience that allows you to arrive at an understanding of what it means to be transparent, what allows another reader to reproduce your work, and how to build credibility.

Although you are not writing the paper to be published in a scientific journal, the research papers that you submit must conform to the standards and conventions described in the American Institute of Physics Style Manual. The standards and conventions of a discipline are not arbitrary but allow for the efficient communication of information. I have posted an abridged version of this manual on D2L. (Some parts of the manual, such as "Correspondence before acceptance", are not pertinent to our particular situation.) The point here is to put you in the same situation as the professional scientist, who must write for a particular audience and reach them through a specific medium, which requires some modicum of standards and conventions.

To help you build an understanding of transparency, reproducibility, credibility, and the standards and conventions of the physics community, I will hold several "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 30-45 minutes to comment on your first two papers before you submit them for a grade. 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. I will not review a draft that is incomplete or does not represent an authentic attempt to be complete. Failure to present a complete draft will also result in the loss of credit 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 commit as much time as is reasonable to make comments on your final draft in order 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 writing the next paper.

Research Presentations:
You will prepare a poster like the ones in the hallway for your third experiment. This will be done with your lab partners. This poster will be put on display for the department (and anyone walking by) to check out. I will gather comments from faculty and other physics majors.

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.

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

- (2) Research Papers ........................................ 25% each
- (1) Research Poster Presentation.................. 25%
- (1) Research Presentation ............................ 25%

I will assign each paper and the presentation a letter grade of A, B, C, D, or F, using (+), (-), and (/) to achieve a resolution of 15 grades, based on my professional judgment, which is articulated in the grading rubrics posted on D2L.

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.
Although I am the person who assigns a grade to your work, keep in mind that, during the research presentations, other faculty in the department will evaluate your work and submit their evaluations to me for consideration. I will take their thoughts and comments into full consideration.

**Misconceptions:**
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 practicing writing makes you a better writer, independent of reading. Because of these misconceptions, it might not make sense to you 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 the words of that discipline relate to one another, their juxtaposition and relative meaning, and the context in which those words are used, as well as the structure of the language within a discipline.

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.

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. Yet, 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.

**Common University Syllabus Content: (See Document on D2L)**

**ACADEMIC & PERSONAL INTEGRITY**
It is the responsibility of each student to adhere to the university’s standards for academic integrity. Violations of academic integrity include any act that violates the rights of another student in academic work, that involves misrepresentation of your own work, or that disrupts the instruction of the course. Other violations include (but are not limited to): cheating on assignments or examinations; plagiarizing, which means copying any part of another’s work and/or using ideas of another and presenting them as one’s own without giving proper credit to the source; selling, purchasing, or exchanging of term papers; falsifying of information; and using your own work from one class to fulfill the assignment for another class without significant modification. Proof of academic misconduct can result in the automatic failure and removal from this course. For questions regarding Academic Integrity, the No-Grade Policy, Sexual Harassment, or the Student Code of Conduct, students are
encouraged to refer to the Department Undergraduate Handbook, the Undergraduate Catalog, the Ram’s Eye View, and the University website at www.wcupa.edu.

STUDENTS WITH DISABILITIES
If you have a disability that requires accommodations under the Americans with Disabilities Act (ADA), please present your letter of accommodations and meet with me as soon as possible so that I can support your success in an informed manner. Accommodations cannot be granted retroactively. If you would like to know more about West Chester University’s Services for Students with Disabilities (OSSD), please visit them at 223 Lawrence Center. The OSSD hours of operation are Monday – Friday, 8:30 a.m. – 4:30 p.m. Their phone number is 610-436-2564, their fax number is 610-436-2600, their email address is ossd@wcupa.edu, and their website is at www.wcupa.edu/ussss/ossd.

EXCUSED ABSENCES POLICY
Students are advised to carefully read and comply with the excused absences policy, including absences for university-sanctioned events, contained in the WCU Undergraduate Catalog. In particular, please note that the “responsibility for meeting academic requirements rests with the student,” that this policy does not excuse students from completing required academic work, and that professors can require a “fair alternative” to attendance on those days that students must be absent from class in order to participate in a University-Sanctioned Event.

REPORTING INCIDENTS OF SEXUAL VIOLENCE
West Chester University and its faculty are committed to assuring a safe and productive educational environment for all students. In order to meet this commitment and to comply with Title IX of the Education Amendments of 1972 and guidance from the Office for Civil Rights, the University requires faculty members to report incidents of sexual violence shared by students to the University's Title IX Coordinator, Ms. Lynn Klingensmith. The only exceptions to the faculty member's reporting obligation are when incidents of sexual violence are communicated by a student during a classroom discussion, in a writing assignment for a class, or as part of a University-approved research project. Faculty members are obligated to report sexual violence or any other abuse of a student who was, or is, a child (a person under 18 years of age) when the abuse allegedly occurred to the person designated in the University protection of minors policy. Information regarding the reporting of sexual violence and the resources that are available to victims of sexual violence is set forth at the webpage for the Office of Social Equity at http://www.wcupa.edu/_admin/social.equity/.

EMERGENCY PREPAREDNESS
All students are encouraged to sign up for the University’s free WCU ALERT service, which delivers official WCU emergency text messages directly to your cell phone. For more information, visit www.wcupa.edu/wcualert. To report an emergency, call the Department of Public Safety at 610-436-3311.

ELECTRONIC MAIL POLICY
It is expected that faculty, staff, and students activate and maintain regular access to University provided e-mail accounts. Official university communications, including those from your instructor, will be sent through your university e-mail account. You are responsible for accessing that mail to be sure to obtain official University communications. Failure to access will not exempt individuals from the responsibilities associated with this course.
**Course Schedule**

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

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<th>Date</th>
<th>Lecture Activities</th>
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<td>Aug 29, 2018</td>
<td>Orientation (Lecture 1)</td>
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<tr>
<td>Sep 5, 2018</td>
<td>Laboratory Practices and Data Analysis Session #1: The Measure of Uncertainty (Lecture 2)</td>
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<td>Sep 12, 2018</td>
<td>Writing Session #1 - Sample Paper (Lecture 3)</td>
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<td>Sep 19, 2018</td>
<td>Laboratory Practices and Data Analysis Session #2: Chauvenet's Criterion, The Central Limit Theorem (Lecture 4)</td>
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<td>Sep 26, 2018</td>
<td>Laboratory Practices and Data Analysis Session #3: Peak Finding, Modeling Data (linear regression) (Lecture 5)</td>
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<td>Oct 3, 2018</td>
<td>Writing Session #2 - Theory part I (Lecture 6)</td>
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<td>Oct 10, 2018</td>
<td>Writing Session #3 - Theory part II (Lecture 7)</td>
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<td>Oct 17, 2018</td>
<td>Writing Session #4 - Procedure and Data (Lecture 8)</td>
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<td>Oct 24, 2018</td>
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<td>Oct 31, 2018</td>
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<tr>
<td>Nov 7, 2018</td>
<td>Student Presentations (4 students)</td>
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<tr>
<td>Nov 14, 2018</td>
<td>Student Presentations (5 students)</td>
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<td>Nov 21, 2018</td>
<td>No Class - Thanksgiving Break</td>
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<tr>
<td>Nov 28, 2018</td>
<td>Student Presentations (4 students)</td>
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<td>Dec 5, 2018</td>
<td>Final Paper Due</td>
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