

PHY320: Intermediate Physics Lab II (Spring 2020)

Prof. Brandon Mitchell

Room SSS-402A

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Lecture: W 3- 4

Lab: W 4 - 6

Office Hours: My office hours for Spring 2020 are:

M: 3 – 4

Th: 2- 3:30

F: 1 - 2

Occasionally I may be able to meet outside of regular office hours, please email me.

Required Textbook:

An Introduction to Error Analysis, 2nd edition, Taylor

Course Web Page:

D2L

Course information can be found here throughout the semester. The syllabus, important documents and experiment information will be found here.

Content: During the PHY 310 sequence, you conducted several of the classic experiments from the 19th and 20th centuries designed to measure a fundamental constant 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). Those experiments lie at the heart of modern physics, and the structure of the Universe depends critically on the values of these constants, and blah, blah, blah.... That's great and all, but it is time to advance to world of "effects. In PHY320, you will be conducting experiments, where the outcome is an effect described by a theory with a parameter that changes between studied systems such as the g-factor, lattice spacing or the Verdet constant. You will gain an understanding of how the properties of materials or systems are determined through their relationship with other measurable quantities through a theory or model. You will be OK with not truly knowing or fully understanding what you are looking for as you are conducting an experiment. In fact, some experiments may require you to learn additional material not covered until PHY420 (Quantum Mechanics I) or Solid-State Physics (PHY480 – Sometimes), such as the Zeeman effect or X-Ray Diffraction analysis. This happens all the time, I am probably reading a bunch of papers right now to understand a topic that I am not familiar in order to write a grant to perform an experiment tangentially related to it. That's physics!

Expectations: Physics 320 is an approved Writing Emphasis course in the WCU General Education program. The writing sessions, laboratory practices and data analysis sessions, and draft review meetings that take place during the semester, as well as the feedback that the faculty give you on your papers and presentations, and the experimental work that you do throughout the semester, are all designed to help you meet the following General Education goals: (goal #1) students will be able to communicate effectively, (goal #2) students will be able to employ quantitative concepts and mathematical methods, and (goal #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 proficient at using a wide range of experimental tools and measurement techniques common to the modern physics research laboratory.
2. The student will become proficient at estimating and calculating 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.

PHY320 – Exploration of Physical “Effects”: PHY320 will build upon PHY310 and reinforce the ideas how to conduct an experiment, keep track of uncertainty, and come to a conclusion based upon the analysis of the data. In this case, you will be conducting an experiment, where the outcome is an effect described by a theory with a parameter that changes between studied systems such as the g-factor, lattice spacing or the Verdet constant.

During the semester, you must conduct three experiments from the list of PHY 320 experiments below (additional experiments may be added later). You must document those experiments in a laboratory notebook. You must write and submit a one-page conference abstract for all three experiments, and prepare a research presentation and full “conference proceeding” for the third experiment.

- Electron Spin Resonance
- The Hall Effect

- The Zeeman Effect
- The Faraday Effect
- Nuclear Magnetic Resonance¹
- The Sodium Doublet
- Energy loss of electron through a vapor
- X-Ray Diffraction Analysis of Si, NaCl, LiF and/or Al
- Raman Spectroscopy of Silicon*

¹This experiment requires as a pre-requisite successful completion of the half-life experiment.

*This experiment may not be available in Spring 2020

The Laboratory Notebook: You will maintain a laboratory notebook during this course as you did in PHY 170/180/310. Your laboratory notebook will serve as the foundation on which your research papers and presentation are built. Your laboratory notebook must be available for review at all times to substantiate any of the claims that you make in your research papers or presentation.

Laboratory Practices and Data Analysis: As in PHY 310, 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 presentations.

You are on your own to assemble the apparatus needed 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. You 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.

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.

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. If the value that you obtain for 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 component of that experience involves comparing the results of your experiments to well established values in the literature. 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 \$350,000. Single items can be quite expensive, too. For example, the Fabry-Perot etalon costs \$3,500, the x-ray diffractometer costs \$22,000 and the Princeton Instruments Pixis CCD camera costs \$85,000.

Food and Drink are strictly 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.

Upon the **second offense**, you fail this course.

Despite the high cost of the equipment, caring for the equipment requires no special training. 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. 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 is available on D2L. You will automatically receive a failing grade for the course if I find that you have tampered with any of the locks. You may also be evicted from the Physics program after an inquiry into the nature of the crime. (See the Physics Student Handbook.)
2. I will be available during my office hours to release equipment and take equipment in return.
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 multi-meters. Each has a different tag number. Do not default to requesting multi-meter #1 each time you make a request. Determine which multi-meters are actually in use and choose one accordingly.
4. You may not take possession of more equipment than is required to run one experiment at a time.
5. You will automatically receive a failing grade for the course if I find that you are 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 me.
6. Equipment transfers between groups are not allowed. (The experience of calibrating equipment and assembling an apparatus in order to conduct an experiment is critical to your future success in physics.)
7. You may not join a group to which equipment has already been released. (Your name must appear on the equipment release form for all of the equipment you are using. See #5.)
8. You have three hours after receiving any piece of equipment to check that equipment for damage and report any problems. (See item #10 below.)
9. 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.
10. Penalties for damaged equipment are assessed as follows.

Whenever a piece of equipment is damaged, I will charge all students in the course a "\$100 penalty." (I am not actually charging you \$100. You do not have to pay to replace broken equipment. This is an "accounting mechanism" for grade

penalties, which is described further below.) This charge takes into account the possibility that prior students have abused the equipment in some way, making it susceptible to failure.

I will charge the individual who damaged the equipment the full cost to repair or replace the equipment. If an entire group is responsible for the damage, I will divide the cost to repair or replace the equipment amongst the group.

The group in possession of the damaged equipment must complete a repair order or a replacement part order to my satisfaction before the group may take possession of any additional equipment. (Equipment Repair and Equipment Replacement forms are available on D2L.)

11. If you receive equipment that is damaged, I will begin an investigation into the cause of that damage and assess penalties as I see fit. Appeals may be made to Dr. Nicastro, who will serve as arbitrator.

Penalties are doubled for equipment that is returned damaged without notification.

12. Penalties for damaged equipment translate into grade penalties. After assigning a grade to a paper or presentation, I will deduct a partial letter grade for each increment of \$500 in penalties accrued since the previous paper or presentation. Any remainder carries over to the next graded item. For example, if you receive a B+ on a paper, and you have accrued \$800 in penalties, your grade drops to a B, and the remainder, \$300, carries over to the next graded item.

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.

Automatic failure will result for papers that have the following obvious faults (this is equivalent to a paper being rejected for publication without review).

- More than three (unique) spelling errors.
- More than two incomplete sentences or sentence fragments.
- Failure to define a variable for a physical quantity. (Mathematical constants, such as π , are exempt from this rule.)
- Duplicate definition. (For example, using the variable F to represent the force of gravity on an oil droplet and the same variable, F , to represent the electrostatic force on the oil droplet. Use subscripts to distinguish variables from one another; for example, F_g and F_e . Similarly, using k to represent a spring constant, then, later, κ to represent the same spring constant.)
- Failure to report a numerical value for all of the physical quantities critical to calculating the final result.
- Failure to follow convention for reporting numerical values.
- Content that appears after the reference section.
- Text in Tables and Figures that is not legible.
- Tables or Figures that violate the margins.
- A Table or Figure caption that does not appear on the same page as the Table or Figure.
- Failure to post any authoritative references.

Draft Review: I will meet with each of you, individually, for 10 minutes to comment on your first three abstracts before you submit them for a grade. Please bring two copies of your abstracts 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 abstract. 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 abstract. A similar set of steps will occur for the final manuscript, but I will give 20 minutes to review the draft.

Final Draft: The final draft of each abstract or 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.

Welcome to Peer Review! For your final paper, you will also get reviewed by a faculty member and you will have to respond to their criticisms via a response letter to the editor of the journal...namely me, and submit a revised draft.

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 those for which you have written papers. Your talk is limited to 15 minutes in a 20-minute time slot, leaving 5 minutes for 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.

(3) Conference Abstract.....	15% each
(1) Showing up.....	5%
(1) Research Presentation	25%
(1) Final Paper.....	25%

I will assign each paper, abstract, and presentation a letter grade of A, B, C, D, or F, based on my professional judgment. (My grading criteria for the papers and presentations are articulated in the paper and presentation 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.

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.

Guidelines for Office Hours: You set the agenda for office hours. Come with questions about the lecture, reading, homework, exams, grading, or anything else of concern or interest. Attend in groups or as an individual. If you would like to discuss something in private, please make a separate appointment. When multiple people are present, people will alternate asking questions. **Note:** You must demonstrate some effort/thought process towards an answer on homework problems before coming to see me. "I have no idea where to begin" is not an acceptable opening statement.

Attendance: You are expected to come to every class and perform every experiment that you are assigned.

PHY320 Disclaimer - It is common for students to not attend other physics classes nor complete homework assignments due to time spent on PHY320 experiments, presentations or papers. This class is **NOT** an acceptable excuse to miss other courses, and I expect you will find time to complete all of the work assigned in your other classes.

Grading: A letter grade will be assigned based on performance in the course according to the following scale:

Grade	Quality Points	Percentage Equivalents	Interpretation
A	4.00	93-100	Excellent
A-	3.67	90-92	
B+	3.33	87-89	Superior
B	3.00	83-86	
B-	2.67	80-82	
C+	2.33	77-79	Average
C	2.00	73-76	
C-	1.67	70-72	
D+	1.33	67-69	Below Average
D	1.00	63-66	
D-	0.67	60-62	
F	0	< 60%	Failure

Refer to the Undergraduate Catalog for description of NG (No Grade), W, Z, and other grades.

Straight percentages will be given for all work, with the mid-semester and final grade based on overall class performance. Other considerations will influence your final grade including, class participation, class and laboratory attendance, and seeking timely guidance

during office hours. Any student achieving at a level of 'C-' or below will be given an estimated grade on their mid-term deficiency grade report.

E-Mail and Communication: The best way to contact me is via e-mail. But, be aware that I will only read and respond to e-mails written in proper English, with correct grammar, spelling, and etiquette. Do not send me any e-mails addressed to “hey” or “yo,” like you would text a buddy or close friend.

“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.”

Boiler Plate Language Common to All WCU Syllabi

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 FOR UNIVERSITY-SANCTIONED EVENTS: Students are advised to carefully read and comply with the excused absences policy 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 and due dates for papers during the first class session.

Date	Lecture Activities
Jan. 22	Introduction/Overview, Choosing Experiment/Presentation Scheduling. Laboratory Practices: Experimental Design and Minimizing Uncertainties
Jan. 29	“Lecture 1”
Feb. 5	<i>No Class – Conference</i>
Feb. 12	Writing Session #1: Conference Abstracts and “Lecture 2”
Feb. 19	Lecture 2: How to Write a Scientific Paper and “Lecture 3”
Feb. 26	Lecture 3: How to Give a Scientific Talk
Mar. 4	Lecture 3: How to Give a Scientific Talk
Mar. 11	<i>No Class – Spring Break</i>
Mar. 18	Prof. Mitchell and Other Faculty Talks
Mar. 25	(5) Practice Presentations
Apr. 01	(4) Practice Presentations
Apr. 08	(4) Practice Presentations
Apr. 15	(5) Presentations
Apr. 22	(4) Presentations
Apr. 29	(4) Presentations
May xx	Final Papers Due