

DEPARTMENT OF PHYSICS UMBC

PHYS 122L: Introductory Physics Laboratory

Daniel Gonzales

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Office Hours: W/Th 1:00 pm

Office: Physics 324

Lecture: M 1:00 - 1:50 pm PAHB 107 Sections 4/5

& Tu 1:00 - 1:50 pm PAHB 108 Sections 2/3

Course Description

This 3-credit lab course is based on the physical phenomena associated with the PHYS 121-122 lecture-course sequence. The laboratory includes planning a measurement, setting up and working with equipment, and recording data. Students will learn to analyze data, compare theory with experiment, and estimate and report errors. Students will learn to present results in a complete, concise, and clearly written report.

Learning Objectives

The first two weeks will have all the “new material” for the course, and you will learn all the necessary theoretical tools you’ll need when performing experiments for the rest of the semester. The learning objectives associated with weeks 1 and 2 are below:

- Explain the difference between systematic and random error
- Explain what instrumental limit error is and calculate it for digital and analog scales
- Report the measured value and uncertainty for a measurement
- Describe how many significant figures are associated with a measured value
- Statistically analyze a data set to determine the mean; standard deviation; standard deviation of the mean; and total uncertainty
- Apply the principles of error propagation to determine uncertainties
- Graph data sets which should include: a title, labeled axes with correct units, error bars, best fit line, and equation for best fit line

- Perform a least squares fit for a data set to determine: slope and y-intercept of best fit line, uncertainty of the measured y-values, and the uncertainties of the slope and y-intercept
- Linearize a data set and perform the same least square fit analysis as above

The rest of the semester will be spent on applying the theoretical principles your learning from PHYS 121/122 to experiments in the laboratory. The learning objectives associated with the experiments are:

- Observe physical phenomena familiar from your lecture courses. Become familiar with the intricacies of working in a lab, such as how to plan a measurement, how to set up and use equipment, and how to take and record data.
- Learn how to analyze your data and compare theory with experiment.
- Learn to present your results in a complete, concise, and clearly written report. (In the real world your work is usually judged by what you write about it: you prepare a report for your manager in industry, a dissertation as a graduate student, a research paper in academia. Fair or not, a badly written reports is dismissed, no matter how great the work itself would be otherwise.)

Required Textbook

There is no required textbook for this course. All new material will be provided for the students. However, it may be helpful to have your textbook or course material from PHYS 121 & 122 as a reference, as we will be using some of that material in our labs. Additionally, in the first two weeks, we will be covering the topics of statistical and error analysis. An excellent reference textbook on this material is Taylor's **An Introduction to Error Analysis**. Of all the textbooks used during my undergraduate courses, this is by far the one I have referred to the most in my professional and graduate work.

Prerequisites/Corequisites

Completion of PHYS 122(H) with C or higher or concurrent enrollment. You should also have a good working knowledge of equations and concepts from PHYS 121 & 122 as well as knowledge of calculus (derivatives & integrals), trigonometry, geometry, and algebra.

Instructional Team

- **Instructor:** Daniel Gonzales: DPGonzales@UMBC.edu
- **TAs:**
 - Carson Evans: cevans5@umbc.edu
 - Ashlyn Wright: ashlynw1@umbc.edu

Course Structure

This course is designed to be taken *in-person* and is *not* a hybrid or remote course. All lectures will be held in person.

Weekly Schedule

- **Lectures:**
 - Sections 4/5 M 1:00 - 1:50 pm PAHB 107
 - Sections 2/3 Tu 1:00 - 1:50 pm PAHB 108
 - Instructor-led sessions whereby new material is presented. You are expected to have already done the reading.
- **Labs:**
 - Section 4 M 2:00 - 5:00 pm PHYS 110
 - Section 2 Tu 2:00 - 5:00 pm PHYS 110
 - Section 5 W 2:00 - 5:00 pm PHYS 110
 - Section 3 Th 2:00 - 5:00 pm PHYS 110
- **Office Hours:**
 - Instructor: W/Th 1:00 - 2:00 PHYS 324
 - Carson: M/Tu 10:00 - 11:00 am PHYS 226A
 - Ashlyn: Th/F 11:00 - 12:00 am PHYS 226A
 - Additional appointments may be made with the instructor or TAs as needed.
- **Weekly Due Dates** See the **Tentative Class Schedule** section for details.
 - **Pre-Class Quiz:** due electronically prior to the beginning of each lecture.
 - **Homework:** when assigned, it will be due electronically prior to the beginning of your assigned lecture period.
 - **Lab Report/Analysis Report:** when assigned, they will be due electronically prior to the beginning of your assigned lab session.

Pre-Class Quiz/Class Work

Each week, you will have a Blackboard quiz to complete, preparing you for that week's material. These will be due before your assigned lecture period. They will cover material from the lab manual, so be sure to read through it beforehand. You'll have three attempts per quiz. Feel free to work with each other on the quizzes, but make sure you understand how to think through and approach all the questions yourself.

The lecture will help prepare you for that week's lab. In addition to the pre-lab quiz, there will also be work during class time either preparing you for lab that week or assessing your understanding of the previous week's material. Once we start labs, you will be completing a

quiz associated with the material for that week's lab during class. You are encouraged to work with each other on the quiz.

I will drop the two lowest Pre-Class Quiz/Class Work grades from your overall score.

Homework

Two homework assignments based on the first and second week's material. Find on BB in the Week 1 & 2 folders. Expect to spend an average of at least 4-6 hr on each homework assignment. Plan to start early so that you can get help in office hours.

Homework assignments are to be turned in by electronically as a PDF, and are due at the beginning of your assigned lecture period. late submissions will not be accepted. Your work must be either clearly and neatly handwritten or typed using a word processor. For a solution that requires calculations in Excel, include a printout of your spreadsheet with the main answer circled or highlighted. Everything on your spreadsheet should be clearly labeled, so the grader can easily tell what each cell/column/row represents. For any calculations you perform in Excel, you must explicitly show the formula you are using. You are encouraged to collaborate with your classmates, however each student must have their own unique solutions and be able to explain their solutions to the instructor. You are forbidden from using any external sources except the instructor, TA, classmates, and class notes.

Working in the Lab

Lab will be in Physics 110. No food or drink allowed in lab. Ordinarily, you'll work with one lab partner. Be on-time; at the beginning of lab there's typically a ~5 min orientation to the apparatus that you shouldn't miss, plus labs can require the whole lab period. Late penalties: up to 15 min late: 10%; 15-30 min late: 20%; 30 min+ late: too late to participate (possible makeup lab with appropriate excuse.) LabArchives is where you will access the lab manual and your own lab notebook. You must record all your data, observations, calculations, and any variations from the standard procedure in your lab notebook. Before leaving lab you must have either the TA or instructor check your notebook and you must also pick up your lab station. You'll complete most of your data analysis after lab, but time permitting, get started on it during lab. It's easy to get help and you might realize you missed some important data needed in your analysis.

Lab Reports

There will be a total of 5 lab reports due throughout the semester. To receive full credit for a lab report, you must attend the lab, take data, submit measurements & graphs, and submit an electronic copy of your report on BB in PDF format. After submitting your electronic copy, it is your responsibility to make sure it has been uploaded correctly and your paper has the proper format. You can review your submission by going to "My Grades" on BB and clicking on that lab's lab report. Please don't email the instructor or the TA lab reports, they will be deleted.

Reports must be typed using a word processor and should conform to the format supplied in the sample lab report. It must be spell-checked and written in clear English. (Publishers return manuscript without review, if language is full of errors.)

You may talk to your classmates and lab partner regarding the lab reports, but each of you must submit your own original text, graphs, analysis, and report. Copying someone else's work is

cheating. Refer to Lab Report Grading Guide under Course Materials in Blackboard for detailed grading criteria. Here are some of the important elements:

- All analysis detailed in the lab manual
- All conceptual questions are answered in the analysis/conclusion
- "Quality of language" means it is objective, precise, and concise (in addition to being proper English). Avoid rambling and vague phrases like "human error"
- Logical organization and flow
- Error evaluation in your report
- Apply what you learned in lecture– always include error, correct sig figs, etc.
- Describe the error method: "s.d. of mea", "added in quadrature", "I used ___ function in ___ program"
- In the APPENDIX, include error propagation formulas (esp. ones that use partial derivatives). You can also attach Excel tables (printed out or pasted in). If you do some extended analysis, derivations can go here, too.
- ILE can usually be stated once: "All values in this table..."
- Figures and tables
- No ambiguity– include labels, captions and units!
- When plotting data, it should come with error bars. This can be individual measurement error, or it can be error from the least squares fit (Z parameter). Always specify.

Analysis Reports

For four labs instead of writing a full lab report, you will be submitting an analysis report which will include all the important elements of lab reports such as reporting data, discussion of results, and error analysis. The format is not as strict as the lab report and will be more like a series of questions you'll need to answer for each lab. More details on analysis reports will be provided.

Late Submissions for Assignments

No late submissions will be accepted for homework assignments, in-class work/quizzes, or quizzes on Blackboard. One lab or analysis report (excluding the independent investigation lab report) can be submitted up to two days late with a 15% penalty for each day late. In order to submit your report late, you must email the instructor before it is due letting him know you'll be submitting it late. Failure to notify the instructor means you can not submit your report late, and you'll earn a zero. No other late submissions for lab reports or analysis reports will be accepted and a grade of zero will be earned if the report is not turned in on time.

Make-up Lab Policy

Deadlines for assignments are firm, and the above late penalties will be applied for late submissions. However, please let me know as soon as you can of any documented extended illness or family responsibilities that may impact your ability to keep up in the class, and we'll try to make a plan to keep you on track to succeed! There is a makeup week for labs near the end of the semester.

If you know in advance that you will miss a lab session due to a scheduling conflict, you may be able to make up the lab the same week. You **MUST** inform the instructors and TAs at least 24 hours in advance of missing your assigned lab session *and* be able to attend a different lab session that same week. This opportunity will only be granted once for any student.

Independent Investigation

Most of the semester, you'll be performing measurements and analysis which we prescribe for you, and for which the expected outcome is known. In contrast, you'll spend the last few weeks of the semester in uncharted waters, designing and carrying out an investigation on a topic of your own choosing. Elements of your independent investigation include:

Proposal: A few paragraphs addressing (1) what you want to do and why, and (2) how you plan to carry it out (both collection and analysis of data), and (3) equipment requirements (there will be an inventory of available equipment that you can use). You must work with a lab partner for your investigation, though only one proposal needs to be submitted. The proposal itself will be submitted on BB. I'll discuss with you and your lab partner and offer written comments. (5% of independent investigation grade.)

Written report: Same as a regular lab report that you'd submit throughout the semester. (50% of independent investigation grade)

Presentation: 12 min presentation (10 min, 2 min for questions). Motivate the question you asked, describe how you designed your experiment, and summarize your results and analysis. Include any lessons learned that you might apply next time. (45% of independent investigation grade, evaluated by instructors and classmates)

Some general criteria: It doesn't matter how close you come to resolving the question you ask of nature – much more important is the process. Do you make a convincing case that your question is interesting and worthwhile? Do you make some use of the elements of planning measurements or data analysis that you've learned? Did you take advantage of feedback you received during planning? Do you show evidence that you've shared the work – taken the lead on some aspects, while checking on those aspects your partner has led?

Grading Policy

The standard 10% per letter grade scheme will be used. Below will be the following breakdowns with S being the final score for a student in the class.

A+	$S \geq 97\%$	C+	$80\% > S \geq 77\%$
A	$97\% > S \geq 93\%$	C	$77\% > S \geq 73\%$
A-	$93\% > S \geq 90\%$	C-	$73\% > S \geq 70\%$
B+	$90\% > S \geq 87\%$	D	$70\% > S \geq 60\%$
B	$87\% > S \geq 83\%$	F	$60\% > S$
B-	$83\% > S \geq 80\%$		

The instructor reserves the right to curve the scale depending upon on overall class scores at the end of the semester. Any curve will only ever improve a student's grade.

The grade will count the assessments using the following proportions:

- **10%:** Pre-Class Quiz/Class Work (Drop two)
- **80%:** Homework and Reports
- **10%:** Independent Investigation

All scores will be posted to Blackboard. It is the student's responsibility to check Blackboard to make sure that their grades are correct. If there are any errors, the student must contact their TAs immediately to resolve the problem. All posted scores become final one week after they are posted.

Technology Use:

UMBC requires all students to be technologically self-sufficient, which entails having a **reliable personal computer** (preferably a laptop with webcam) and **Internet access**. Since UMBC requires all students to have a computer and Internet access, financial aid may be used to meet this requirement. To learn more, students should contact their financial aid counselor at financialaid.umbc.edu/contact. In addition, the Division of Information Technology (DoIT) provides a wealth of resources and support, including tips for getting online and minimum specifications to consider when purchasing a computer (doit.umbc.edu/students)

- **Blackboard:** Assignments, class slides, lab notes, and announcements will be posted on Blackboard as well as your grades. It is your responsibility to keep up to date with the course materials and announcements posted on Blackboard.
- **LabArchives:** This is where you will access the lab manual and your own lab notebook. You must record all your data, observations, calculations, and any variations from the standard procedure in your lab notebook.
- **Microsoft Word and Excel:** These programs are available for free to download as a UMBC student. The necessary features are available in any version. If your data evaluation required the use of a spreadsheet, attach it to your lab report. Incorporate only the main results and plots in the main text of the report.
- **Webex:** Options to meet with the TAs and/or instructor via Webex will be available. If for any reason we need to move to a fully remote course, Webex will be used for lectures and office hours. If this happens, details regarding the move to a fully remote course will be communicated to all students.

Academic Integrity and Honesty

All instances of academic misconduct will be addressed according to the UMBC Policy on [Academic Integrity](#). Examples include attempting to make use of disallowed materials on assignments, soliciting help by posting material on the internet for any assignment, looking at posted material from others online, altering graded work and submitting it for regrading, asking someone else to take an assignment in your place, copying another's work on an assignment, asking someone else to do an assignment and representing it as your own, permitting or assisting another student to carry out any of the above, or any other instance of academic misconduct. Penalties range from a grade of 0 on the assignment to an F in the course (at my discretion), and from denotation of academic misconduct on the transcript to expulsion (as determined by official hearing of the Academic Conduct Committee).

It is my firm belief that no student enrolls in a course with the intention of cheating their way through it. Rather, as a course progresses and a student falls behind their goals, they see cheating as a desperate resort to get back on track. If you find yourself in this situation, please reach out for help from the instructor and TAs. Every one of you can pass this course with resorting to cheating, let the instructional team help you out if you feel overwhelmed.

Contacts

- Contact your TAs with questions regarding grades or for general help.
- Contact the instructor, Daniel Gonzales (DPGonzales@UMBC.edu), for anything not satisfactorily handled above, complaints about TA performance or behavior, final grade inquiries, or suggestions for improvements to the lab curriculum.
- Please cc both TAs and the instructor on all emails, unless the subject is of a personal or private nature.

Tentative Course Schedule

Week	Topic	Assignment Due	Due Date
1 8/28	Short Week No Lecture, No Labs		
2 9/4	Labor Day No Lecture, No Labs		
3 9/11	Course Policies, Uncertainty Error Propagation and Data Analysis	Syllabus Quiz	Beginning of Lecture
4 9/18	Plotting, Least Squares Fitting Data Linearization	HW 1	Beginning of Lecture
5 9/25	Group A: Atwood's Machine (LR) Group B: Ballistic Pendulum (AR)	HW 2	Beginning of Lecture
6 10/2	Group A: Ballistic Pendulum (AR) Group B: Atwood's Machine (LR)		
7 10/9	Group A: Simple Harmonic Motion (AR) Group B: Angular Momentum (LR)	Atwood & Pendulum LR & AR	Beginning of Lab
8 10/16	Group A: Angular Momentum (LR) Group B: Simple Harmonic Motion (AR)	Independent Investigation Proposal	Beginning of Lecture
9 10/23	Group A: Heat Capacity and Latent Heat (LR) Group B: e/m Ratio of the Electron (AR)	SHM & AM LR & AR	Beginning of Lab
10 10/30	Group A: e/m Ratio of the Electron (AR) Group B: Heat Capacity and Latent Heat (LR)		
11 11/6	Group A: DC Circuits and Ohm's Law (AR) Group B: The Current Balance (LR)	e/m Ratio & Heat Capacity AR & LR	Beginning of Lab
12 11/13	Group A: The Current Balance (LR) Group B: DC Circuits and Ohm's Law (AR)		
13 11/20	Independent Investigation Thanksgiving and American Indian Heritage Day	DC Circuits & Current AR & LR	Beginning of Lab*
14 11/27	Independent Investigation Make-Up Labs		
15 12/4	Student Presentations	Presentation Slides & Write Up	Beginning of Lecture
16 12/11	Student Presentations (if need be, else no class)		

* For the Thanksgiving holiday, Thursday's AR & LR will still be due on Thursday at 2:00 ET. You are of course free to turn it in early. Sorry.

Accessibility and Disability Accommodations, Guidance and Resources

Accommodations for students with disabilities are provided for all students with a qualified disability under the Americans with Disabilities Act (ADA & ADAAA) and Section 504 of the Rehabilitation Act who request and are eligible for accommodations. The Office of Student Disability Services (SDS) is the UMBC department designated to coordinate accommodations that create equal access for students when barriers to participation exist in University courses, programs, or activities.

If you have a documented disability and need to request academic accommodations in your courses, please refer to the SDS website at sds.umbc.edu for registration information and office procedures.

SDS email: disAbility@umbc.edu

SDS phone: 410-455-2459

If you will be using SDS approved accommodations in this class, please contact the instructor to discuss implementation of the accommodations. During remote instruction requirements due to COVID, communication and flexibility will be essential for success.

Sexual Assault, Sexual Harassment, and Gender Based Violence and Discrimination

[UMBC Policy](#) in addition to federal and state law (to include Title IX) prohibits discrimination and harassment on the basis of sex, sexual orientation, and gender identity in University programs and activities. Any student who is impacted by sexual harassment, sexual assault, domestic violence, dating violence, stalking, sexual exploitation, gender discrimination, pregnancy discrimination, gender-based harassment, or related retaliation should contact the University's Title IX Coordinator to make a report and/or access support and resources. The Title IX Coordinator can be reached at titleixcoordinator@umbc.edu or 410-455-1717.

You can access support and resources even if you do not want to take any further action. You will not be forced to file a formal complaint or police report. Please be aware that the University may take action on its own if essential to protect the safety of the community.

If you are interested in making a report, please use the [Online Reporting/Referral Form](#). Please note that, if you report anonymously, the University's ability to respond will be limited.

Notice that Faculty and Teaching Assistants are Responsible Employees with Mandatory Reporting Obligations

All faculty members and teaching assistants are considered Responsible Employees, per UMBC's [Policy on Sexual Misconduct, Sexual Harassment, and Gender Discrimination](#). Faculty and teaching assistants therefore required to report all known information regarding alleged conduct that may be a violation of the Policy to the Title IX Coordinator, even if a student discloses an experience that occurred before attending UMBC and/or an incident that only involves people not affiliated with UMBC. Reports are required regardless of the amount of detail provided and even in instances where support has already been offered or received.

While faculty members want to encourage you to share information related to your life experiences through discussion and written work, students should understand that faculty are required to report past and present sexual harassment, sexual assault, domestic and dating violence, stalking, and gender discrimination that is shared with them to the Title IX Coordinator

so that the University can inform students of their rights, resources, and support. While you are encouraged to do so, you are not obligated to respond to outreach conducted as a result of a report to the Title IX Coordinator.

If you need to speak with someone in confidence, who does not have an obligation to report to the Title IX Coordinator, UMBC has a number of [Confidential Resources](#) available to support you:

[Retriever Integrated Health](#) (Main Campus): 410-455-2472; Monday – Friday 8:30 a.m. – 5 p.m.; For After-Hours Support, Call 988.

[Center for Counseling and Well-Being](#) (Shady Grove Campus): 301-738-6273; Monday-Thursday 10:00a.m. – 7:00 p.m. and Friday 10:00 a.m. – 2:00 p.m. (virtual) [Online Appointment Request Form](#)

Pastoral Counseling via [The Gathering Space for Spiritual Well-Being](#): 410-455-6795; i3b@umbc.edu; Monday – Friday 8:00 a.m. – 10:00 p.m.