

DEPARTMENT OF PHYSICS UMBC

PHYS 13XL: Introductory Physics Laboratory

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Fall 2026

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Lecture: Tue 9:00 - 9:50 am Physics 101

Course Description

This course is actually three courses in one. The courses are labeled 131L, 132L, and 133L. The courses are taken concurrently and will have the same lecture period. All resources are also the same for all courses. The key difference between the courses is that they are respectively one, two and three credit courses. As such, 133L will cover more material than 132L which will cover more material than 131L. Additionally, 131L is only five weeks long and will conclude after the exam in the fifth week. 132L is just ten weeks long and will conclude after the second exam in the 10th week. Meanwhile, 133L will run the full length of the semester.

The reasons for offering the three different courses at three different lengths is because different majors require various breadths with respect to the topic of experimental measurement. 133L is intended for physics majors. While 132L is intended for bio-chem and computer science majors, and 131L is intended for mechanical engineering majors. **Be sure to consult with your academic advisors to make sure you are enrolled in the correct course.**

This syllabus is intended to be a single reference for all three courses. When there are differences between the courses they will be stated explicitly, therefore for any particular point if no explicit course is referenced you may assume the policy applies to all three courses.

This is an introductory lab course based on the physical phenomena associated with PHYS 121-122 lecture 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, estimate their experimental errors and how to properly report their results.

Learning Objectives

In this course, you will learn how to apply the tools of statistics and error propagation to quantify the results of physical experiments that you will perform. Most of the physical phenomena explored in these experiments will have been introduced to you in Physics 121 and 122. The following are the learning objectives associated with this course:

- Scientific Communication – Students will learn and practice:
 - how to report the results of a measurement in proper form, using the best estimate and the estimated error.
 - how to properly report a series of data in the form of a graph/plot with error bars (132L/133L).
 - how to present their findings in a clearly written report (132L/133L).
 - how to present their findings in a clear and concise presentation (133L).
- Data Analysis – Students will understand and properly apply the following data analysis procedures and concepts:
 - Error/uncertainty estimation
 - Error/uncertainty propagation
 - Fractional uncertainty
 - Types of errors
 - Measurement comparison
 - Linearization (132L/133L)
 - Post-regression analysis (132L/133L)
 - Leading error contributions (132L/133L)
- Statistical Methods – Students will understand how to compute and properly apply the following statistical methods to measured data:
 - Arithmetic mean
 - Standard deviation
 - Standard deviation of the mean
 - Weighted mean
 - Linear least-squares regression (132L/133L)

Textbook

The textbook **An Introduction to Error Analysis** by John R. Taylor is required for 132L and 133L, and it is *highly recommended* for 131L. The most recent edition is the third edition and is the “required” edition. However, I will be preparing my material from the 2nd edition. The 2nd edition is excellent and only missing one advanced topic on Bayesian statistics from the 3rd edition that will not be covered in this course. I found some physical copies of the 2nd edition online for as low as \$20. Digital copies are acceptable.

Taylor is a superb book on statistical analysis. I have used it as a reference many times in my professional and academic careers. For students working towards careers in science and engineering, it is a good one to have on your bookshelf.

Prerequisites/Corequisites

Completion of PHYS 122 or 122H with a C or higher or concurrent enrollment. You should 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 & Contact Information

- **Instructor:** Daniel Gonzales: DPGonzales@UMBC.edu
- **TAs:**
 - Alaynah Shahid: AShahid1@UMBC.edu
 - Lisa Saji : LisaS4@UMBC.edu
- **LAs:**
 - Elammen Batista: EBatist1@UMBC.edu

How to contact us:

- **Use the discussion board on Blackboard** for general help on the course work or questions about the course structure. This is by far the best form of asynchronous communication for the course. If you have a question about the course or content, often another student will have the same question. Posting it to the discussion board makes it much more efficient for the instructional team to address questions to the whole class.
- **Attend the instructor and TA office hours** for specific help with the coursework. (Office hours schedule can be found in the Weekly Schedule section.)
- Contact your TAs with questions about grades.
- Contact the instructor 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.

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

Weekly calendar for the course.

Time	Tuesday		Wednesday		Thursday	
9:00	Lecture					
10:00	Instructor OH					
11:00						
12:00						
13:00	LA Session		Instructor PTC		Instructor PTC	
14:00	133L Lab	Lisa PTC	132L S2 Lab		132L S3 Lab	Alaynah PTC
15:00						
16:00						
17:00						
18:00						
19:00	131L S2 Lab		132L S3 Lab			
20:00						
21:00						

- **Lectures:** Instructor-led sessions whereby new material is presented. You are expected to have already done the reading.
 - Tue 9:00 - 9:50 am Physics 101
- **Labs:** TA led sessions whereby students will perform their physical labs. All labs will be held in PHYS 110.
 - 133L §2 Tu 2:00 - 4:45 pm with Dr. Gonzales
 - 131L §2 Tu 6:00 - 8:45 pm with Alaynah
 - 132L §2 We 2:00 - 4:45 pm with Alaynah
 - 131L §3 We 6:00 - 8:45 pm with Alaynah
 - 132L §3 Th 2:00 - 4:45 pm with Lisa
 - 131L §4 **Cancelled**
- **Office Hours:** All TA office hours and some of the instructor's will be held in the Physics Tutorial Center in PHYS 226A. Additionally, students are free to seek help from the tutorial center at any time, not just when the instructor, or TAs will be there. The hours of operation for the tutorial center are: Monday through Thursday, 12 noon to 5 pm.
 - Alaynah Shahid: Th 2:00 - 4:00 pm
 - Lisa Saji : Tu 2:00 - 4:00 pm
 - Instructor PTC Hours: W & Th 1:00 - 2:00 pm
 - Instructor Non-PTC: Tu 10:00 - 11:00 am in PHYS 110
 - Additional appointments may be made with the instructor or TAs as needed.
- **LA Session:** A session where our LA will answer questions regarding the course material. Held in the lab, PHYS 110.

– Tu 1:00 - 2:00 pm

- **Weekly Due Dates:** See the **Tentative Class Schedule** section for details.

- Almost all assignments will be due at the beginning of your lab session. All out-of-class assignments will be due electronically through Gradescope or Blackboard.
- Exceptions will be clearly posted in the Blackboard assignments.
- Note, Blackboard does *not* support different due dates for different groups/sections of students. Gradescope does allow for this. The due dates for assignments are set in Gradescope and often Blackboard will simply say there is no due date. Therefore, **if an assignment says “no due date” in Blackboard, double-check the due date in Gradescope.** Turning in an assignment late because Blackboard cannot display it properly is not an excuse because you have been warned of this issue.

Working in the Lab

Experiments will be conducted in the laboratory Physics 110. No food or drink is allowed in the lab.

You will conduct these experiments with a lab partner. These pairs will be randomly assigned each week. Your seating assignment for the week, which determines your partner and your role in the group, will be posted on the door to the lab at the beginning of the week.

When working with your partner, there are two different roles for each of you to perform. These roles are also randomized each week. The roles are that of the **operator** and the **recorder**. The operator handles all the physical equipment, makes the measurements, and reads the the instruments. For any hands-on activities, the operator should be the one doing it. The recorder records the data into Excel and/or a notebook. They are responsible for organizing the data, sharing it with their partner(s), and double-checking their values with the operator. While both students are responsible for reading the lab manual ahead of time, the recorder is responsible for interpreting the instructions and, when both students are unclear of what to do, asking for help from the TA or instructor. In cases where three students are in a group, the third student will assist the operator and double-check the instrument readings.

Be on time; TAs will issue the pre-lab quiz to be completed in the first 15 minutes. The quiz will cover some basics regarding the lab to be done. In preparation for the quiz/lab, you should have read the lab manual and watched the short video on the lab. **Students that show up more than 15 minutes late will not be able to start or complete the lab.**

Common excuses for arriving late to lab include trouble turning in their assignment, trouble finding parking, traffic, and traveling between classes. These are tasks nearly *everybody* has to deal with, so please plan ahead to make sure these don't jeopardize your chances of fully participating in the class.

The instructions for the lab can be found in the lab manual located on Blackboard. You must record all your data, observations, calculations, and any variations from the standard procedure. Before leaving lab, you must have either the TA or instructor check you out to make sure you have collected all the correct data. They will also check to make sure your lab station is clean and tidy. Some short analysis will be done during the experiments. However, you'll complete most of your data analysis after you have finished your experiment.

A Note on Randomized Partners

I can imagine some of you may not be a fan of randomized student partners. I know this is different from what some of you may be used to, so I'd like to explain why.

One of the goals of this course is to help you develop the skills needed to work effectively with other people. In science, engineering, medicine, and industry, you rarely get to choose your collaborators. Learning how to communicate, divide responsibilities, solve problems together, and adapt to different working styles is an important part of your education.

Rotating partners also has several practical benefits:

- You'll get to know more of your classmates and build a broader network of people you can study with throughout the semester.
- You'll be exposed to different approaches to solving problems and analyzing data.
- It ensures that everyone has the opportunity to contribute, rather than falling into fixed roles within the same group.
- It reduces the chance that one person carries the workload while another simply follows along.
- If personalities don't mesh well with one partner, that pairing only lasts for one lab instead of the entire semester.

I also hope this creates a classroom environment where everyone feels included. No one has to worry about finding a partner each week or about being the person left without a group.

I understand that many of you have friends you enjoy working with, and there will certainly be opportunities outside of lab to study together. During the lab period, however, I ask that you embrace the opportunity to work with different people. You may be surprised by how much you can learn from classmates you might not otherwise have met.

Of course, if there is a legitimate concern that affects your ability to work with a particular student, please speak with me privately, and I will handle the situation appropriately.

Assessments

Your grade will be determined by your performance on the following types of assessments:

- **Lab Analysis Reports (LARs):** The most common assignment for this course. These consist of responses to questions/prompts about the physical experiments you performed in the lab. Each lab comprises one complete chapter in the lab manual. For most labs, there will be multiple experiments conducted; some labs will only do one experiment. The procedures for the experiments will be in the second section of each chapter. Unless stated otherwise, the LARs need to be completed for all subsections of that section, often labeled "Experiments" or "Procedures." The responses will be in the form of numerical answers, short responses, and plots of data. These assignments mimic typical physics and math homework more than reports. These reports should be **typed**, and turned in to Gradescope. These will be due before your lab session the week following the experiment.

- **Pre-Lab Quizzes:** A short 15-minute quiz will happen every lab session and precede the experiments to be performed. This quiz is based on the experiments you *will be* performing in lab that day. To prepare for the quiz, you should read the lab manual for the experiment and watch the short video of the instructor going over the experiment.
- **Lab Attendance:** The TAs will take attendance **at the end** of the lab session. If you finish your experiment(s) early, you may work toward completing your LAR for the remainder of the lab session.
- **Exams:** These will test your individual ability to perform specific analysis tasks on hypothetical data. These will be held during the lab period in lieu of performing an experiment. These exams are highly weighted in the overall scoring rubric for the course.
- **Formal Report (FR) (132L & 133L):** A typed and written report on the experiment performed in the lab. This is to be a logically consistent report expressing the results of your experiment, measurements you made, and the rationale that leads from the measurements to the results. It should be readable in the form of well-structured sections, with full paragraphs and complete sentences. Standard college-level writing skills should be used for these assignments. Detailed information on what is expected in these formal reports will be made available to the class.
- **Final Project (133L Only):** The majority of the last third of the semester will be dedicated to students completing their final project. Most of the semester, you will be performing measurements and analysis on experiments that are prescribed for you and for which the outcome is known. In contrast, your project will be to design and carry out an experimental investigation on a topic of your own choosing.

This is a team effort, and, for the most part, the grade on this assignment will be shared by all students in the group. However, the instructor reserves the right to adjust the grades for individuals for egregious instances of asymmetrical work and/or communication within the group. Not completing the project will result in a failing grade for the course, no matter what the student's performance is leading up to the final project.

There are multiple elements for the final project. Detailed information on what is expected in these elements will be made available to the class. They include:

- **Initial/Final Proposals:** (The following is how the proposals worked in previous semesters. However, the instructor is considering changing this part of the project for this semester. If this happens, the class will be well informed of the structure and student requirements.) Before work is done to build and execute the experiment, the teams must make a proposal for the experiment. These are to make sure the students have a clear idea on what they want to measure and how they will measure it. The initial proposal is very informal and may consist of only a few sentences explaining what the student aims to do. After the initial proposal, all teams will meet with the instructor to help the teams get a more concrete idea of what can be accomplished within the constraints of the course. The final proposal will be more formal and should include details on what quantities the students will measure, how they will measure them, and how they will analyze their data to make a reasoned determination about the proposed phenomena.

- **Formal Report:** After executing their experiment, the teams, together, will write a single formal report for their investigation. This report will follow all the guidelines and parameters of the other formal reports in the course.
- **Final Presentation:** All members of the team will contribute and participate in a final presentation of their investigation to their class. This presentation will be eight minutes long and followed by a two-minute question and answer period, where the students must answer questions from the class, instructor, and TAs about their experiment.

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

Grading Policy

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

A	$S \geq 90\%$
B	$90\% > S \geq 80\%$
C	$80\% > S \geq 70\%$
D	$70\% > S \geq 60\%$
F	$60\% > S \geq 60$

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.

Each type of assessment will be weighted in the following manner for each of the courses:

Grade weighting for each course.

Assignments	131L	132L	133L
Pre-Lab Quiz	15	15	15
Lab Attendance	5	5	5
LAR	40	20	20
Exams	40	40	20
Formal Reports	-	20	20
Project	-	-	20
Total	100	100	100

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.

For 132L & 133L one LAR and one quiz will be dropped before calculating a student's final grade.

Late Policy and Make-up Labs

Late Assignments

Students are afforded **ONE** late LAR without penalty. In order to do this the student must email the instructor AND the TAs about the late assignment *before* it is due *and* turn in the assignment within 24 hours after the original due date. So long as these two steps are done you will not earn a penalty. You do *not* need to receive a response from the instructors or TAs before the due date of the assignment for this to apply.

This opportunity does *not* apply to formal reports or project deadlines.

All other late assignments will incur a 25% point deduction for every 24-hours the assignment is late.

The deadlines for assignments are firm, and the above 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 will try to make a plan to keep you on track to succeed.

The most common excuse I receive for late assignments is that a student is busy due to other assignments or exams in other classes. While I empathize with students facing heavy loads from other courses, nearly *all* of the students in this course are facing similar issues. The assignment deadlines for this course are well documented and known, each of you should be able to complete the LARs and other assignments within the week you are allowed to complete them. If you are having trouble with time management and would like to talk about it, I, the instructor, am happy to meet with you to give you some advice work this out.

Missing Lab

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 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. If you are unable to come in that week, there will be one week toward the end of the semester where any student can physically perform a missed lab. For 131L make-up labs will happen during week 6. For 132L & 133L make-up labs will happen during week 12.

Furthermore, if you cannot come to your lab session, **the assignment due that day is still due**, and the late penalties described above will still be applied even if you miss a lab. Obviously, missing a lab means you cannot complete the LAR for that lab, therefore an extension on that LAR will be granted.

Tentative Course Schedule

Tentative schedule of topics and lab experiments. 131L only spans the first five weeks in orange. 132L spans the first ten weeks in orange and yellow.

Week	Date	Lecture: Reading	Lab
1	8/24	Uncertainties: Ch 1 & 2	Measurement
2	8/31	Error Propagation: Ch 3	Thermal Lab
3	9/7	Statistical Methods: Ch 4	Resistors
4	9/14	Weighted Averages: Ch 8	Diffraction
5	9/21	Technical Writing	Exam 01
6	9/28	Linear Regression I: Ch 7	SHM
7	10/5	Linear Regression II: Ch 7	Atwood's Machine*
8	10/12	<i>Fall Recess: No Lecture</i>	Capacitors
9	10/19	Measurement Comparison: Ch 5	e/m Ratio*
10	10/26	Final Projects	Exam 02
11	11/2	Project Proposals	Capacitors
12	11/9	Technical Presentations	<i>Project Prototyping</i>
13	11/16	Error Budget	<i>Project Execution</i>
14	11/23	ECS: LIGO	<i>Project Analysis</i>
15	11/30	ECS: Homestake Experiment	<i>Project Writing</i>
16	12/7	TBA	Project Presentations**
* Lab also requires a formal report.			
** Lab will take place in PHYS 401.			

Use of Generative AI

In the instructor's opinion, generative AI tools can be excellent tools to use to make some specific tasks more productive for a user. However, the usefulness of generative AI is largely overestimated. It will not supplant the human imagination that is required to perform scientific inquiry. Use of generative AI is not allowed to be used to perform *ANY* of the work that is asked of the students. Students may use generative AI to: help **edit** their work in the form of clarification of writing, grammar and spelling edits; help them identify experiments for final projects.

The instructor reserves the right to fail any assignment for which he suspects the student relied heavily on generative AI. The instructor also reserves the right to report any such incident to the Academic Conduct Committee for review.

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](#). 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.

- **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.
- **Gradescope:** Assignments should be turned into Gradescope through the Blackboard assignments. There is no need to sign up for an account with Gradescope. It is well integrated into Blackboard that this hasn't been an issue. Turning in assignments through Gradescope takes a little more time than simply uploading an image/PDF of your assignment. You should budget for this time and not wait until the last minute to try to upload your assignment.
- **Microsoft Word and Excel:** These programs are available for free to download as a UMBC student. The necessary features are available in desktop application version. **At some point, we will learn how to plot data with error bars. This is surprisingly difficult, if not impossible, with other spreadsheet applications, including the browser based version of Excel. You are free to use any spreadsheet application you want, but the instructional team cannot offer support for making plots in other applications. You'll be on your own.** Sorry for the bold font in the previous statements. I'm not trying to shout or be stubborn or inflexible. It really is just *that* difficult to make error bar plots in non-Excel applications. 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 without resorting to cheating, let the instructional team help you out if you feel overwhelmed.

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.