PHY 357: Intermediate Physics Lab (Spring 2022, CRN 20128)

Instructor: Dr. Eric Edlund
SUNY Cortland, Physics Department

*Course policies, dates, course organization, and assessment weighting are subject to change if external circumstances beyond my control substantially modify the operation of this course.

Course Meeting Times and Location

Times: MWF 1:50 PM – 3:50 PM
Location: Bowers 139

Contact Info
Email: eric.edlund@cortland.edu
Phone: 753-5697
Office: Bowers 133

Preferred contact method is email or text communication through Microsoft Teams.

Standing Office Hours (online and in-person)

Monday	10:00 AM – 12:00 PM
Tuesday	12:00 PM – 1:00 PM
Wednesday	12:00 PM – 1:00 PM
Friday	11:00 AM – 12:00 PM

Or by appointment:
If you are unable to attend these standing office hours or would like to speak privately about a specific matter, you are welcome and encouraged to make an appointment.

Course catalog description
A laboratory experience stressing precise experimental measurement using a variety of instruments and covering various branches of physics.

General education attributes
This is a **Writing Intensive (WI)** course, a SUNY Cortland General Education designation that you must complete a minimum of 15 pages of writing, which includes opportunities for revision. Your writing requirement will be fulfilled in the lab reports. This course also helps you to fulfill your liberal arts and sciences requirements (LASR).

Course student learning outcomes
Upon successful completion of this course, the student will be able to

1. design experiments to measure physical phenomena;
2. analyze data using appropriate error analysis and statistical techniques;
3. defend data-driven conclusions with appropriate quantitative arguments;
4. evaluate peer results and critique others' procedures;
5. apply peer review critiques to their own work;
6. and present original results in professional written and oral formats.

Writing intensive student learning outcomes

1. Students will undertake an effective writing process and make informed decisions about their writing with input from their instructor.
2. Students will write effectively in the technical style appropriate for physics.

Syllabus last updated: January 24, 2021

Required course materials

- *An Introduction to Error Analysis (2nd edition),* by John R. Taylor
- A dedicated, bound notebook (i.e. not loose-leaf or a 3-ring) for recording lab notes

Online meeting and coordination

We will use Microsoft Teams for all of our class organization activities, including online lectures (if needed), grades, and regular text communications. Please use access code **yytlrg2** to join the team for this class, called **PHY 357 - Spring 2022**.

Note: Please do not use the browser-based app for MS Teams and download the desktop app which is far more stable.

My goals for this course

Physics 357 is the quintessential laboratory experience for upper-division physics majors. In this class you will revisit old experiments and conduct new experiments. My goals for this class are that you:

- conduct experiments with care, precision, and attention to detail;
- conduct experiments that expand your understanding of physics in new areas such as optics, fluid dynamics, and particle physics;
- apply advanced statistical methods to rigorously defend your claims;
- become more skilled in working with hardware and develop better physical intuition for what is and is not possible, feasible, and safe;
- significantly improve your technical writing skills;
- and enjoy your experience and in the process find new passion for your studies.

What you will need to do to be successful in this course

You will be expected to conduct multiple experiments in this course, and to do so with a maturity and focus well above that what is typically seen in 200-level experiments. Success in this course will require you to:

- come to class ready to work and to make the most use of your time;
- understand that this class is not about following procedures to complete experiments, but is about the philosophy of thoughtful experimental design, precision measurements, application of statistics, and communication of observations;
- learn new mathematical techniques, which will require that you read the textbook and complete homework assignments as in other courses, and do so without the use of Chegg or other similar resources;
- embrace communication of your findings as the central goal of your work where you prove both your understanding and written communication skills;
- understand and accept that revisions are an essential part of becoming a better writer and communicator;
- and bring a big can of patience and whole lot of can-do attitude that will empower you to plan ahead, diligently study the equipment, trouble-shoot your experiment, stay cool when you realize that you need to try again, and persist in writing a quality lab report.

Important dates

Monday 1/24	First day of classes
Friday 1/28	End of the add/drop period
Monday 3/14 to Friday 3/19	---------- Spring Break ----------
Friday 5/6	Last day of class (last date for submission of work)
Friday 5/13	Final Exam, 11:00 AM – 1:00 PM

Assessment weighting		Number of assignments in each assessment category
Lab Reports	50%	5 lab reports, one for each of the first five experiments
Pre-lab designs	15%	5 pre-lab design, one for each except for the first
Homework	20%	4 problem sets
Presentation	15%	presentation on your final experiment
Final Exam	10%	the final exam will cover statistical analysis
Total	110%	this is intentional and allows you to skip the final if your grade is sufficiently high

Score-grade equivalence table

	76.7% ≤ **C+** ≤ 79.9%	**E** ≤ 59.9%
93.4% ≤ **A**	73.4% ≤ **C** ≤ 76.7%	
90.0% ≤ **A-** ≤ 93.3%	70.0% ≤ **C-** ≤ 73.3%	
86.7% ≤ **B+** ≤ 89.9%	66.7% ≤ **D+** ≤ 69.9%	
3.4% ≤ **B** ≤ 86.6%	63.4% ≤ **D** ≤ 66.6%	
80.0% ≤ **B-** ≤ 83.3%	60.0% ≤ **D-** ≤ 63.3%	

Note about reports and presentations: We will conduct a total of 6 experiments in this class. The first experiment will be done collectively, and we will work together on the data analysis and writing the report (each student is still responsible for submitting an individual report). You will be graded on individual lab reports for the first 5 experiments. The results of your final experiment will be communicated in a presentation to the class worth 15%. For all but the first experiment (2-6, you must develop a set of pre-lab design notes prior to conducting the experiment.

Any missing/insufficient lab report or presentation will result in a half letter grade (5%) reduction in your final course grade in addition to receiving a zero for that item.

Course policies and explanation of assessment categories

Note that these policies, including the types of assessment used and weighting of assessment areas, are subject to change if the circumstances regarding the operation of this course changes due to factors outside my control.

Masks and Social Distancing Policy: This class will be taught in person. This means that you must wear a mask to class and when visiting me in office hours. Failure to act responsibly in these ways will result in dismissal from class for the day. A second offense is grounds for academic misconduct.

Attendance: Attendance in lab is mandatory as we have limited time to conduct experiments and we will use class time to work on projects. Each unexcused absence in lab will incur a 2% penalty to your course grade. If you are unable to make a class, please contact me to schedule a session to make-up the missed in-class time.

Experiments: You will conduct a total of six investigations. A list of available experiments will be provided to you. You must conduct one experiment from each of the following categories:

Project A: ballistics and error analysis
Project B: wave resonance
Project C: measuring μ_0 and ε_0
Project D: speed of sound or light
Project E: design-your-own-experiment
Project F: modern physics or wind tunnel

Lab reports: A lab report is required for each of the first give experiments. The final experiment will be presented in the form of a spoken presentation to the class. The following conditions apply:

- You will have one opportunity to rewrite each lab report.
- The final score for each report will be a weighted sum of the first and second versions of the report.
- The weighting of the versions will change throughout the term, with the final product being emphasized at the beginning of the semester, and the first version being emphasized at the end of the semester.
- The weighting of the versions will be done according to the following table

	First Draft	**Second Draft**
Lab Report A	30%	70%
Lab Report B	40%	60%
Lab Report C	50%	50%
Lab Report D	60%	40%
Lab Report E	70%	30%

- Feedback will be provided to you in a spreadsheet that identifies common errors and tabulates your score for each report.
- You are highly encouraged to visit with me to discuss your writing in detail and receive feedback about how to improve the clarity, thoroughness, and style of your writing.

Supporting documents for the technical reports:
In addition to the scoring spreadsheet, where you will be able to find a list of common mistakes, you will also be provided with a supplementary style guide and a report template. All reports should be written using Latex, which will be discussed in class. You are strongly encouraged to make an account with the online Latex editing application called *Overleaf*.

Pre-lab designs: Prior to beginning work on any laboratory investigation, you must complete and submit a pre-lab design document. This pre-lab design must be approved before you can begin any actual work on an experiment. In the time prior to beginning the experiment, you may examine the equipment to learn how you will use it. This document must identify six main things:

1. It must define the central research question(s) you will be exploring. Recall that good questions are, typically, quantitative in nature. The question should state what uncertainty you want to achieve in your final measurement.
2. It must outline the theoretical framework that you will use to interpret the results with a sketch of what plots or data will be central to your analysis.
3. It must define the specific measurements you will make (which things in the theory will you directly measure) and how many measurements you expect that you will need to make in order to achieve your desired accuracy.
4. It must list the major equipment needed to conduct the experiment.
5. It must provide an outline of your experimental procedures.
6. It must describe any safety requirements or equipment that you will need to conduct the experiments.

Presentation: In order to pass this class you must make a presentation on your final experiment, which may be something from the realm of modern physics (e.g. the Frank-Hertz experiment) or studies conducted using the wind tunnel. This presentation must include discussions of goals, theory, apparatus, measurements, analysis, and conclusions. Further details will be provided at a later date.

Homework: In addition to developing familiarity with laboratory procedures, we will be studying statistical methods using *Introduction to Error Analysis***.** You will have four problem sets over the course of the semester. While you are free to collaborate, all submitted work must be your own. That means no copying or otherwise directly using another students' work, no use of solution manuals or posted solutions from any outside source, and no use of internet resources like Chegg.

Final Exam: The final exam will focus on theoretical aspects of the class (i.e. statistical analysis techniques), but may also include content from specific experiments, about experimental procedures, and technical writing. The final exam is optional and can be taken to help improve your grade. No late exams will be permitted without a valid reason, as outlined in the college catalog.

Lab notebook: A final check at the end of the semester will be conducted to look for a complete notebook, which is required to receive your 15% credit for the pre-lab designs.

Late work policy: Late work will incur a 10% penalty per day over one week and will not be accepted more than a week late.

Course Schedule

Note that this is a tentative schedule and is subject to change as necessary. In addition to the laboratory work that you will conduct on an on-going basis, we will have regular lecture meetings to discuss statistical analysis, various theoretical topics, and the style and process of technical writing. The list of topics below covers only the lecture topics for the week, and does not in any way relate to the experiments that you will be conducting.

An important note on time management: You will be self-paced in these labs. Plan for each experiment to be conducted on a 3-week cycle. In the first week you will want to study the equipment and make an experimental plan on Monday, aiming to be ready to begin conducting experiments on Wednesday with a completed pre-lab plan. For the next week and a half, until the end of week 2, you should focus on perfecting your methods and techniques, refining your measurements, taking a preliminary stab at the analysis, and drafting your lab report. In week 3 you will simultaneously complete your lab report and start the next laboratory experiment at the beginning of this cycle.

Week	Date			Lecture Topic	Ch.	P-Set	Lab Report
1	1/24	to	1/28	Uncertainties and error	1&2	-	-
2	1/31	to	2/4	**WI:** Technical reports & Latex	2	-	-
3	2/7	to	2/11	Probability distributions	2	#1	A
4	2/14	to	2/18	**WI:** How to write an abstract	3	-	-
5	2/21	to	2/25	Propagation of uncertainty	3	-	B
6	2/28	to	3/4	**WI:** Research workshop	3	#2	-
7	3/7	to	3/11	**WI:** Critical editing workshop	4	-	C
8	3/14	to	3/18	<SPRING BREAK>	-	-	-
9	3/21	to	3/25	The standard deviation	4	-	-
10	3/28	to	4/1	Systematic & random error	4	-	D
11	4/4	to	4/8	Measures of statistical quantities	4	#3	-
12	4/11	to	4/15	Normal distributions	5	-	-
13	4/18	to	4/22	Normal distributions in Excel	5	-	E
14	4/25	to	4/29	**PS:** The scientific presentation	5	#4	-
15	5/2	to	5/6	**Student Presentations (Project F)**	5	-	-
16	5/9	to	5/13	**Final Exam** on May 13, 11:00 AM			

WI = Writing Intensive topic **PS = Presentation Skills**

An important note about due dates: The last two columns of the schedule, for the problem sets and the lab reports, indicate the week in which the assignments are **due**. All assignments are officially due at the start of class on Friday of the indicated week. Lab rewrites are due one week after feedback is returned to you.

SUNY Cortland Policies and Statements

Academic Integrity Statement: All students are expected to uphold academic integrity standards. Plagiarism is defined as taking the ideas of others and using them as one's own without due credit. Students who cheat in examinations, course assignments, or plagiarize in this course may be disciplined in accordance with university rules and regulations. SUNY Cortland College Handbook, Chapter 340.

Disability Statement: As part of SUNY Cortland's commitment to a diverse, equitable, and inclusive environment, we strive to provide students with equal access to all courses. If you believe you will require accommodations in this course, please place a request with the Disability Resources Office at disability.resources@cortland.edu or call 607-753-2967. Please note that accommodations are generally not provided retroactively so timely contact with the Disability Resources Office is important. All students should consider meeting with their course instructor who may be helpful in other ways. SUNY Cortland College Handbook, Chapter 745.

Diversity Statement: SUNY Cortland is dedicated to the premise that every individual is important in a unique way and contributes to the overall quality of the institution. We define diversity broadly to include all aspects of human difference. The College is committed to inclusion, equity, and access and thus committed to creating and sustaining a climate that is equitable, respectful and free from prejudice for students, faculty and staff. We value diversity in the learning environment and know that it enhances our ability to inspire students to learn, lead and serve in a changing world. We are committed to promoting a diverse and inclusive campus through the recruitment and retention of faculty, staff and students. As a community, we hold important the democracy of ideas, tempered by a commitment to free speech and the standards of inquiry and debate. To this end, we are dedicated to developing and sustaining a learning environment where it is safe to explore our differences and celebrate the richness inherent in our pluralistic society. SUNY Cortland College Handbook, Chapter 130.

Inclusive Learning Environment Statement: SUNY Cortland is committed to a diverse, equitable and inclusive environment. The course instructor honors this commitment and respects and values differences. All students enrolled in this course are expected to be considerate of others, promote a collaborative and supportive educational environment, and demonstrate respect for individuals with regard to ability or disability, age, ethnicity, gender, gender identity/expression, race, religion, sex, sexual orientation, socio-economic status or other aspects of identity. In an environment that fosters inclusion, students have the opportunity to bring their various identities into conversation as they find helpful, but are not expected to represent or speak for an entire group of people who share aspects of an identity. If you have any questions or concerns about this statement, contact the Institutional Equity and Inclusion Office at 607-753-2263. http://www2.cortland.edu/about/diversity/

Title IX Statement: Title IX, when combined with New York Human Rights Law and the New York Education Law 129-B, prohibits discrimination, harassment and violence based on sex, gender, gender identity/expression, and/or sexual orientation in the education setting. The federal Clery Act and NY Education Law 129-B provide certain rights and responsibilities after an incident of sexual or interpersonal violence. When a violation occurs, victims and survivors are eligible for campus and community resources. Where the College has jurisdiction, it may investigate and take action in accordance with College policy. If you or someone you know wishes to report discrimination based in sex, gender, gender identity/expression, and/or sexual orientation, or wishes to report sexual harassment, sexual violence, stalking or relationship violence, please contact the Title IX Coordinator at 607-753-4550, or visit http://www2.cortland.edu/titleix to learn about all reporting options and resources.
Updated by SUNY Legal on February 1, 2018.