Lahore University of Management Sciences

PHY 300 / PHY 500 – Experimental Physics Lab II / Graduate Physics Lab

Fall 2023

To understand how to navigate course outlines, consult: How to Use a Course Outline (http://surl.li/gpvuw)

Instructor	Dr. Muhammad Hamza Humayun
Room No.	Advanced Physics Lab
Office Hours	Not applicable
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Telephone	
Lab Instructor	Dr. Muhammad Hamza Humayun
TA Office Hours	Not applicable
Course URL (if any)	http://physlab.org/lab-ii-phy-300/
Support Services	LUMS offers a range of academic and other services to support students. These are mentioned below, and you are encouraged to use these in addition to in-class assistance from course staff. For a complete list of campus support services available for you click here (https://advising.lums.edu.pk/#supportservices)

Course Basics				
Credit Hours				
Lecture(s)	Nbr of Lec(s) Per Week	N/A	Duration	N/A
Recitation (per week)	Nbr of Rec (s) Per Week	N/A	Duration	N/A
Lab (if any) per week	Nbr of Session(s) Per Week	1	Duration	See timetable issued by Registrar's office.
Tutorial (per week)	Nbr of Tut(s) Per Week	N/A	Duration	N/A

Course Distribution	
Core	For Physics Majors and Physics Graduate (MS) Students
Elective	SSE
Open for Student Category	SSE
Closed for Student Category	N/A

COURSE DESCRIPTION

The course introduces the students to advanced and more rigorous experiments in physics, in which they cover a variety of important fields of physics through hands-on experiments of varying complexity and

duration. The course is offered mainly for students majoring in physics, as most of it deals with the advanced concepts of physics and needs knowledge of fields varying from quantum mechanics optical physics, and solid-state devices. Students are required to independently carry out the experiments and record their observations in properly maintained journals, demonstrating the essence of experimental science. Marking and evaluation greatly depend on students' capability to properly accumulate and critically interpret the experimental observations, which they have to prove in the form of reports.

Teaching Methodology
The course is scheduled for in-person/on campus as it involves hands-on laboratory experiments. The first two weeks are dedicated to teaching computational tools such as graphing, and basic programming for quantitative analysis. In the remaining 12 weeks, students are assigned individual experiments to perform, record and analyze results, and present their findings in the form of technical reports. At the same time, students are required to keep their lab notebooks.

COURSE PREREQUISITE(S)	
•	Experimental Physics I (PHY 100) for undergraduates

COURSE OBJECTIVES	
•	Advanced physics experimentation
•	Scientific report-writing
•	Stimulating research activity and building new hardware for research in experimental physics

Learning Outcomes	
	After successful completion of this course, students should be able to: 1. operate advanced scientific instruments with a keen sense of safety, ratings, and ability to interpret various modes of operation; 2. obtain an appreciation of vacuum and low-temperature systems, building hardware, thermal control of equipment, using measurement sensors and transducers, condition signals, and acquiring data into the computer; 3. analyze and interpret physical data acquired from experiments and correlate them with rigorous theory; 4. comment on corroboration of experimental results with theoretical predictions, explore the limitations of experimental work, and devise ways of improving and adapting experimental schemes for enhancing precision, accuracy, and robustness; and finally,

	5. write technically advanced scientific reports.

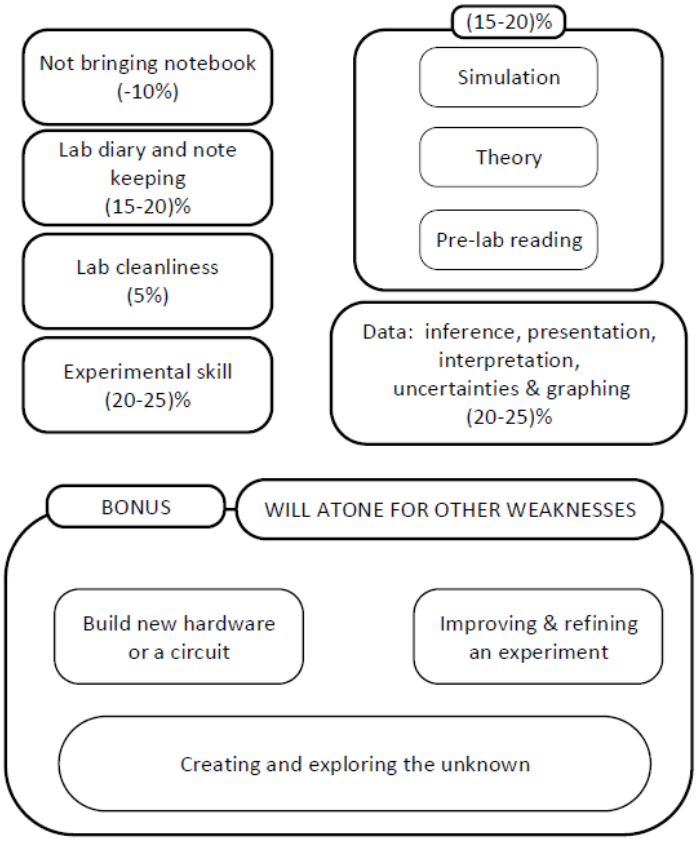
Grading Breakup and Policy

See the grading scheme that will be uploaded on http://physlab.org/lab-ii-phy-300/ .

Grading will be on an absolute scale. However, I will decide the cutoffs based on my judgment.

Preparatory work and assignments (uncertainties, think-aloud experiments, open source tasks in Python, LabVIEW, computer-aided design)	100
Technical Report 1	25
Technical Report 2	25
Experiments (10 weeks of experimental work)	300
Total Marks	450

Mental Picture for Grading:



- Is the abstract really an abstract? Are the conclusions really conclusions?
- Are the sections titled properly? For example in an experiment that looks at the Franck-Hertz experiment using an oscilloscope, it is quite inappropriate to title a section "*The Oscilloscope*". The measuring apparatus is simply a tool that reveals the ionization curve of mercury in the Franck-Hertz tube. Yes, if you are performing an experiment aimed at understanding the lock-in amplifier, sections titled "*Working Principle of a Lockin amplifier*" is quite apt.
- Avoid shopping lists of apparatus and equipment. The apparatus you use must be seamlessly integrated into the main text.
- Avoid reproducing text and figures from the laboratory manuals.
- Be consistent in capitalization. Avoid excessive capitalization: "*the cathode*" instead of "*the Cathode*" should be preferred.
- Don't copy-paste the figures churned out by MATLAB. They have to be pruned, the fonts adjusted, the sizing has to make the axes and the labels readable, unwanted legend boxes showing "*data 6*", "*data 7*" don't mean anything. I am looking for publication quality figures. Vector graphics are preferred where possible. Gain familiarity with a nice graphics software. For example, Python can integrate latex symbols and fonts into vector graphics with little to no need for post-processing. For post-processing Adobe Illustrator or its open source counterpart Inscape are very useful. You are free to use graphics software of your choice.
- All symbols and figures should be in LaTeX's math mode. Units are preferred outside the math mode.
- Appropriate paragraphing is important. Each paragraph should start, in many cases, with a topic sentence. At the end of every paragraph, I should expect what to find next. This interwoven theme should be made clear at the very beginning. In short, don't make the report feel like a hop-on, hop-off route in a labyrinth, rather it should come out as one, logically consistent, unified thematic journey through the experiment.

- Only relevant theory must be discussed.
- Of course, grammar and style also matters. No need to be overly verbose, simple, succinct, short sentences are effective.
- Avoid using imperative tense and the second pronoun ("*you will lift a beaker*"), rather passive voice and past tense ("*the beaker was placed*").
- Use proper sentences. Each sentence ends with a full stop. An equation is a part of a sentence. All sentences must end.
- Avoid starting sentences with "and", "now", "also", "then", with symbols and numerals (1,2,565,-3, E, Vi) etc.

What am I specially looking for:

- Does the report intelligently choose the kinds of graphs that reveal underlying physical patterns. Are the variables correctly chosen? Are the scales appropriate? Do we have close-ups of regions that show some salient features, such as kinks, transitions, or other forms that are not visible in zoomed out views.
- Are similar graphs strung together as sub-figures or are they spattered as distinct graphs with their individual numberings.
- Is there sufficient level of cross-referencing and linking of graphs and tables.
- I am not interested in an uninteresting account of the procedure regurgitated from the manual, rather a concise description of the procedure interwoven with insight, discussions, suggestions and interpretations. This is by far the most important thing that I am looking for.
- Is the bibliography uniform? Are the citation schemes the same or different across the various references? Learning how to populate .bib file and use it with biblatex is very helpful in being consistent and strongly recommended.

- Are the experimental parameters clearly stated?
- Are there sufficiently neat schematic illustrations that aid the readability of the text?

Marks will be deducted for:

- Not complying to rules of the lab: one must bring a lab notebook which is defined as a hard bound diary; one must leave the lab with all the apparatus in neat and orderly fashion so that it is ready for the next group. Leaving cluttered pages and your personal belongings in the lab
- Missing a lab session: there will be no make-up labs
- Arriving late.
- Arriving in the lab without reading the experiment manual of the assigned experiment.

Examination Detail	
Midterm Exam	None
Final Exam	None

Week/ Lecture/ Module	Topics
1-2	Software carpentry (plotting, data analysis, scripting)
3	Measurement and uncertainties
4-5	Workshop practice (3D printing, OpenScad), Electrical soldering
6	Orientation with PhysLogger and Data Acquisition/ Video tracking
7-14	Experimental Work (see next)

Here is a sample list of experiments:

http://physlab.lums.edu.pk/index.php/Experiment_in_Lab-II

In addition, we will offer these new modules:

- Single Photon Quantum Mechanics https://physlab.org/qmlab
- Earth's field NMR https://physlab.org/story/earth-field-nmr/

Textbook(s)/Supplementary Readings
Listed on course website: http://physlab.lums.edu.pk/index.php/Experiment_in_Lab-II

Campus supports & Key university policies

Campus Supports

Students are strongly encouraged to meet course instructors and TA's during office hours for assistance in course-content, understand the course's expectations from enrolled students, etc. Beyond the course, students are also encouraged to use a variety of other resources. (Instructors are also encouraged to refer students to these resources when needed.) These resources include Counseling and Psychological Services/CAPS (for mental health), LUMS Medical Center/LMC (for physical health), Office of Accessibility & Inclusion/ OAI (for long-term disabilities), advising staff dedicated to supporting and guiding students in each school, online resources (https://advising.lums.edu.pk/advising-resources), etc. To view all support services, their specific role as well as contact information click here (https://advising.lums.edu.pk/#supportservices).

Academic Honesty/Plagiarism

LUMS has zero tolerance for academic dishonesty. Students are responsible for upholding academic integrity. If unsure, refer to the student handbook and consult with instructors/teaching assistants. To check for plagiarism before essay submission, use similarity@lums.edu.pk. Consult the following resources: 1) Academic and Intellectual Integrity (http://surl.li/gpvwb), and 2) Understanding and Avoiding Plagiarism (http://surl.li/gpvwo).

LUMS Academic Accommodations/ Petitions policy

Long-term medical conditions are accommodated through the Office of Accessibility & Inclusion (OAI). Short-term emergencies that impact studies are either handled by the course instructor or Student Support Services (SSS). For more information, please see Missed Instrument or 'Petition' FAQs for students and faculty (https://rb.gy/8sj1h)

LUMS Sexual Harassment Policy

LUMS and this class are a harassment-free zone. No behavior that makes someone uncomfortable or negatively impacts the class or individual's potential will be tolerated.

To report sexual harassment experienced or observed in class, please contact me. For further support or to file a complaint, contact OAI at oai@lums.edu.pk or harassment@lums.edu.pk. You may choose to file an informal or formal complaint to put an end to the offending behavior. You can also call their Anti-Harassment helpline at 042-35608877 for advice or concerns. *For more information: Harassment, Bullying & Other Interpersonal Misconduct: Presentation (http://surl.li/gpvwt)*