Physics 405: Advanced Experiments
Section 101

Syllabus - Fall 2024

Dr. Simone Kulin

Credits: 3.
Prerequisites: PHYS375 and the associated mathematics courses, or special permission.

Course Overview:

Physics 405 is an advanced undergraduate laboratory course with experiments from many fields of modern physics for physics majors. Over the course of the semester, you will perform **FOUR** experiments that touch on a variety of topics in modern physics. Students have full access to the experimental equipment. Students' schedule and work will be largely self-directed, guided by the Lab Manual and by consulting with your professor(s), staff, TA(s) and/or other students in the course. Emphasis is on **independent** experiment organization, data acquisition, data analysis and fitting, presentations and writing clear lab reports. A schedule with certain deadlines is given at the end of this syllabus. Please avoid having to rush to meet the deadlines. (You can even get a bit ahead of the schedule shown, if you want and have the time in the early and middle part of the semester.) You will write up your analysis and findings from each experiment in a "notebook" format. In addition, you will give a presentation to your classmates about one of your experiments, provide comments for your peers on their presentations, and you will write a formal paper to report on one of your experiments.

Participation at the Wednesday lectures (Toll 1219) is mandatory unless you have a valid excuse. Required safety training and presentations will also take place during this time. Providing feedback to your peers is impossible without attending.

Health:

When working in lab and/or meeting in classroom, the University's health protocols and guidelines will be followed. Please reschedule your lab session if you are not feeling well.

Course materials for this course will all be available in ELMS, free of charge. This includes lab manuals, sign-up sheets, schedules, guidelines for formal reports, etc. All assignments will be submitted to ELMS in pdf and zip formats. If you decide to work with a paper lab notebook, please scan the relevant pages and submit them as a single pdf.

Updated course information is provided through ELMS announcements. Please check regularly.

Class Meeting Schedule:

- **Lectures/Presentation sessions:** Wednesday 12:00-12:50 pm. Room: Toll 1219.
- **Lab Time:** You schedule your own time in the lab, Monday- Thursday 9 am – 5 pm and on Friday from 9 am – 4 pm. Two time slots are available each day. A link to the online sign-up sheet is available on the course home page in ELMS. Please see rules for choosing labs below.

Contacts:

Instructor	E-mail	Office
Dr. Simone Kulin	skulin@umd.edu	Toll 3311 Phone: 301-405-6186
Staff		
Greg Wolter	gwolter1@umd.edu	Toll 3202
Allen Monroe	amonroe@umd.edu	Toll 3331* *ring doorbell in hallway
Teaching Assistant		
Shourya Mukherjee	mshourya@umd.edu	

Office Hours: By appointment. You can try stopping by our offices at any time, but if you can't find us, make an appointment by e-mail.

Preparing to Do the Experiments:

For each experiment, you must read the Lab Manual chapter ahead of time, work out answers to the pre-lab questions in your lab notebook **and submit your answers at least 24 hours before you have scheduled to begin working on that experiment in the lab**. We need this time to check your answers and provide feedback to make sure you are sufficiently prepared to do the experiment. **The lab staff will only let you into the lab at the scheduled time if you have a score of 8 or higher recorded in the ELMS gradebook**. It is not uncommon that a prelab gets a lower grade and must be revised, please plan accordingly.

In the Lab:

Science is often collaborative, and you are welcome to ask us and your classmates for help and advice. We (instructor and TA) will not be in the lab most of the time, but we will try to drop in regularly. Prof Ouyang, who teaches the parallel section, might also come by certain days. You can also contact us to discuss something or to arrange a meeting. It is expected that you do the actual experiment and analyze the data yourself.

As described in the lab manual, the lab staff (Mr. Wolter and Mr. Monroe) are there to maintain the equipment and to help resolve any equipment problems that might arise. If you can't figure out how to operate the equipment or think something may be malfunctioning, check with them. But they are not there to show you how to do the experiment. That is for you to work out (with the available equipment) with the guidance of the Lab Manual and possibly also with advice from instructors and classmates.

Typical format of each lab is that students work independently without a lab partner. You are required to submit a weekly report with lab log and data, as well as a lab notebook after having completed each of the four experiments.

Recommended Texts:

The lab manual has the references pertinent to that particular topic and experiment. In addition, you might find the text books find useful:

(1) *Building Scientific Apparatus*, 4th *ed*. J.H. Moore, C.C. Davis and M.A. Coplan, Cambridge University Press.

(2) *A Practical Guide to Data Analysis for Physical Science Students*, Louis Lyons, Cambridge University Press.

(3) *Introduction to Error Analysis***,** John R. Taylor, University Science Books.

(4) *Data Reduction and Error Analysis for the Physical Sciences*, P. R. Bevington and D. K. Robinson, McGraw-Hill Education.

(5) *The Elements of Style*, William Strunk and E.B White, ESBooks.

Grading:

5% Pre-lab questions

5% Weekly report with snapshots of experimental logs & data (graded for completion)

50% Lab Notebooks: experimental logs (thoroughness and clarity), analysis and reporting of results (format and correctness), and answers to postlab questions in lab manual.

10% Presentation (12+3 min)

5% Peer feedback on presentations (must attend all presentations)

25% Formal lab report.

**All four experiments must be completed in order to pass the course.* Final grades will be computed based upon the above weightings. Standard grading will be followed (e.g. A is 90-100, B is 80-90, etc.) *unless* the class's distribution of scores is unusual, in which case a standard curve will be used.

Late or missed work:

In this course it is largely your own responsibility to manage your time. Deadlines during the semester are set to help you maintain a relatively steady pace, so that you'll have enough time to do a good job on all your experiments. With that in mind, you should plan your work well in advance of the deadlines, and you must meet those deadlines (otherwise, we may assess a grading penalty of 5% per day) unless you have a valid excuse according to university policies. If you are ill, please let us know your situation as soon as possible, and we will work with you and be as flexible as we can. **Do not come to the lab or to class if you feel sick**.

The Lab Notebook – an Experimentalist's Log

Every experimental scientist keeps a complete record of what is/was done in the lab. Always imagine that someone else might have only your notes available and must duplicate the experimental results a year later. The more complete the notebooks are, the better.
What you should include:

- Each entry starts with the date and the experimenter's name.
- Name and number of the experiment you chose to work on
- (For this course only) Answers to the prelab questions
- State the goal for the lab session of the day
- Basic idea behind the experiment (include variables you'll change/measure/keep constant)
- Sketches and diagrams of the apparatus and the set-up. Do not include pictures of the equipment, instead, draw a block diagram that shows how the different pieces of equipment are connected, and how data is collected. Label each pieces of equipment (e.g. laser, vacuum chamber, oscilloscope, etc.). Sometimes it might be advantageous to have multiple sketches of this kind. Including only pictures will reduce your score.
- Organize your data: all numbers must have neat accompanying text describing the measured physical quantity, units, uncertainties. Whenever meaningful make a table.
- If you have acquired data, include filenames. Sketch the graphs you obtained, or print out raw data graphs, label all axes with units.
- Perform order of magnitude calculations whenever possible to check that you are on the right track with your work.
- If you run into problems while doing the experiment, document the issue, write down your plan to address the problem next time you come back
- Justify the steps to analyze the data, always show your reasoning. Work out calculations algebraically before substituting numbers
- Include all calculations pertinent for data analysis (this may include sample graphs, fits to data, results, uncertainty estimates and complete error propagation calculations, evaluations of the goodness of a fit)
- Clearly state the final result of your experiment, and quantitatively compare it to an accepted value when appropriate.
- Answer all post-lab (discussion) questions in the Laboratory Manual
- A brief conclusion of your project. For example, what have you learnt from this lab?
- Mistakes are not to be erased, scratched over or covered with White-Out. A single line is to be drawn through mistakes. You are not allowed to change your Experimental Log after measurements.
- Do not hesitate to write down your thoughts about anything related to the experiments and their analysis.

For each weekly experiment report, please submit to ELMS a single pdf file with a brief summary of what you have achieved during that week, and add the relevant pages from your notebook (electronic or scanned from your paper notebook). Submit the lab notebook as pdf, and the data files and the code for analysis in a zip file.

The Formal Lab Report

In addition to carrying out experiments, scientific research also involves publishing the results of the experiments. Preparing a paper for publication is often an iterative process that involves numerous revisions. The available space is often limited by the journal and writing clearly and concisely is another important skill to acquire. You will prepare a lab report, modeled after a scientific paper using a template in Latex on the Overleaf platform for an experiment that you conducted (see schedule for due dates). After receiving feedback, you will revise it and resubmit. Details about what makes a good paper will be discussed in one of the Wednesday lectures.

All reports need to be submitted electronically in pdf format through ELMS by the due dates. Please note that the rules regarding plagiarism are relevant to lab reports. Large cut and pastes from the lab manual are not allowed. Any cut and paste of more than a sentence should be formatted following standard rules, to make it very clear which text comes from other's work. Similarly, all figures in the formal report must be your own. You cannot use a figure from the lab manual.

The grade for the formal report is the higher grade between the grade for the 1st version and 90% of the grade earned on the 2nd version.

Presentation:

Each student will give a 12 min Power-point presentation to the class on one experiment that you have carried out during the semester. All presentations will take place during the Wednesday class time in the last three weeks of the semester, and attendance is mandatory. To avoid hearing multiple presentations on the same topic the same day we might need to coordinate presentations. A sign-up link is available on ELMS. Please do not change someone else's sign-up without consulting the person first. Guidelines for presentations will be discussed during one of the Wednesday lectures. You must also provide feedback to your peers about their presentation. Guidelines will be provided. You are expected to do this for all presentations.

Academic integrity: The University of Maryland, College Park has a nationally recognized Code of Academic Integrity, administered by the Student Honor Council. This Code sets standards for academic integrity at Maryland for all undergraduate and graduate students. As a student you are responsible for upholding these standards for this course. It is very important for you to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the Code of Academic Integrity or the Student Honor Council, please visit http://www.studenthonorcouncil.umd.edu/whatis.html. In particular it is never permissible to submit someone else's work as your own - you need to prepare your own lab report, you cannot let anyone else submit your report as their own or as a joint report, and you cannot submit someone else's report as your own.

Tips for Doing Well:

Read the laboratory manual carefully before beginning an experiment. Answer the pre-laboratory questions in your notebook and have them checked by the Professor or TA before beginning the experiment. Keep a complete log for the experiment as detailed above. Record clearly the reasoning used to arrive at conclusions. If the experimental result does not agree with the known or accepted value, documented reasoning may be the only means for determining what went wrong. Additional information, a list of experiments, and more detailed help can be found at the course website. ***Good time management is essential for success in this class. Don't fall behind! Don't wait until the last day to do an experiment!***

Policy on collaborating:

You must do all your own work, i.e. everything you write in your lab notebooks (including answers to pre-lab questions) and reports must be your own words. Plagiarism will not be tolerated. However, we encourage you to discuss and consult with the instructors (faculty and TA) and with other students who have done the same experiment before you. Science is all about collaborating and sharing knowledge and advice.

Religious observances:

If you need to miss a class session or a deadline due to a religious observance, please notify us in advance.

Students with disabilities:

Accommodations will be provided to enable students with documented disabilities to participate fully in the course. Please discuss any needs with us at the beginning of the semester so that appropriate arrangements can be made.

Weather or emergency closures:

If the university is closed for a day or two due to bad weather, for instance, then we will just deal with the disruption. We'll ask you to reschedule any lab work that got disrupted. We won't normally change assignment deadlines, but will be flexible if you run up against a deadline due to a closure.

Notice of Mandatory Reporting of sexual assault, sexual harassment, interpersonal violence, and stalking: As a faculty member, I am designated as a "Responsible University Employee," and I must report all disclosures of sexual assault, sexual harassment, interpersonal violence, and stalking to UMD's Title IX Coordinator per University Policy on Sexual Harassment and Other Sexual Misconduct.

If you wish to speak with someone confidentially, please contact one of UMD's confidential resources, such as CARE to Stop Violence (located on the Ground Floor of the Health Center) at 301-741-3442 or the Counseling Center (located at the Shoemaker Building) at 301-314-7651.

You may also seek assistance or supportive measures from UMD's Title IX Coordinator, Angela Nastase, by calling 301-405-1142, or emailing titleIXcoordinator@umd.edu.

To view further information on the above, please visit the Office of Civil Rights and Sexual Misconduct's website at ocrsm.umd.edu**.**

Disclaimer: The instructor reserves the right to make minor changes to this syllabus to meet the specific needs of the class during the semester.

Tentative Schedule for Fall 2024_PHYS405 Section 101

Week	**Experiments**	**Wednesday Class** (12-12:50 pm, Toll 1219)	**Work Due** **(always Wed 12:00 PM)**
Aug 26 – Aug 30	**No Lab**	Logistics & Intro to experiments	Understand all course requirements;
Sep. 3 – Sep 6	**Exp A**	**Radiation Safety Training***	Signup for Experiments; **Prelab A**
Sep 9 – Sep 13	**Exp A**	Lab notebooks and uncertainties	1st weekly report and preliminary data
Sep 16 – Sep 20	**Exp A**	More uncertainties	2nd weekly report and data;
Sep 23 – Sep 27	**Exp B**	**Laser Safety Training***	Lab Notebook for Exp A; **Prelab B**
Sep 30 – Oct 4	**Exp B**	Vacuum	1st weekly report and preliminary data
Oct 7 – Oct 11	**Exp B**	Detectors	2nd weekly report and data;
Oct 14 – Oct 18	**Exp C**	Optics	Lab Notebook for Exp B; **Prelab C**
Oct 21 – Oct 25	**Exp C**	How to write a good paper	1st weekly report and preliminary data
Oct 28 – Nov 1	**Exp C**	Nuclear reactor visit	2nd weekly report and data;
Nov 4 – Nov 8	**Exp D**	How to prepare a good talk	Lab Notebook for Exp C; **Prelab D**
Nov 11 – Nov 15	**Exp D**	Presentations (3)	**Formal Lab Report** 1st weekly report and preliminary data
Nov 18 – Nov 22	**Exp D**	Presentations (3)	2nd weekly report and data;
Nov 25 – Nov 29	No Labs	Thanksgiving break	
Dec 2 – Dec 6	**No Labs**	Presentations (3)	Lab Notebook for Exp D
SUN Dec 8	**Revised Formal Lab Report Due 11:59 PM** **NO LATE SUBMISSIONS**		

*** Mandatory attendance**

Every student needs to carry out FOUR different experiments A, B, C, D during the semester. Two of the experiments need to be chosen from Experiments 2, 5, 6, 8, 9, 10. Experiment 7 is prerequisite for Experiment 9.
It is imperative that you respect your time slot for the presentation. Any potential conflict must be resolved as early as possible, but there is no guarantee that we can accommodate your request.