**Summary Outline for Physics 493L**

**Course design**

Students will perform physics experiments, record their data in their lab notebooks, complete written reports, and then present their results to the class. There are no lectures, quizzes, or exams.

**Experiments and Course Schedule**

There are five experiments to choose from. Some have instructions; some do not. Each student will work alone. Due to current public health consideration, each student will complete only 3 experiments over the course of the semester, allowing each student ample time to complete each experiment. However, the limited number of experiments means we must **strictly** adhere to a schedule to ensure everyone gets a fair opportunity with each experiment.

| **Week** (1st Mon.) | Activity | Deliverable | Notes |
|---|---|---|---|
| **1** (1/18/21) | Experiment #1 Week 1 | | No class 1/18 (MLK day) |
| **2** (1/25/21) | Experiment #1 Week 2 | 1/25: Pre-lab | |
| **3** (2/1/21) | Experiment #1 Week 3 | | |
| **4** (2/8/21) | Experiment #1 Week 4 | | |
| **5** (2/15/21) | Presentation and written report | 2/17: Presentation<br>2/19: Written report | No class 2/15 (President Day) |
| **6** (2/22/21) | Experiment #2 Week 1 | 2/22: Pre-lab | |
| **7** (3/1/21) | Experiment #2 Week 2 | | |
| **8** (3/8/21) | Experiment #2 Week 3 | | |
| **9** (3/15/21) | Experiment #3 Week 4 | | |
| **10** (3/22/21) | Presentation and written report | 3/24: Presentation<br>3/26: Written report | No class 3/22 |
| **11** (3/29/21) | Experiment #3 Week 1 | 3/29: Pre-lab | |
| **12** (4/5/21) | Experiment #3 Week 2 | | No class 2/7 (Wellness Day) |
| **13** (4/12/21) | Experiment #3 Week 3 | | |
| **14** (4/19/21) | Experiment #4 Week 4 | | |
| **15** (4/26/21) | Presentation and written Report | 4/28: Presentation<br>4/30: Written report | No class 4/26 |

**Experimental Pick-up/Drop-off**

*For students local to the University Park Campus:* Each student will be responsible for **picking up** and **dropping off** their experiment from and to University Park Campus. The following is the proposed schedule for pick-up and drop off days:

| Experiment | Pick-up date and **hours** | Drop-off date and hours |
|---|---|---|
| #1 | 1/15/21, **1-3 PM** | 2/16/21, **1-3 PM*** |
| #2 | 2/19/21, **1-3 PM** | 3/22/21, **1-3 PM** |
| #3 | 3/26/21, **1-3 PM** | 4/26/21, **1-3 PM** |

*Different hours may be arranged for 2/16/21 as this corresponds to a Tuesday and not a Monday or Friday for all other dates.

*For students not local to the University Park Campus:* Each student will be **shipped** an experiment. Within each experiment will be all the equipment and tools needed to complete the experiment, packing materials needed to ship the experiment safely, and packing slip for the next delivery. **It is imperative that students take notes on how each experiment was packed when receiving each experiment so that each experiment can be safely re-packed and shipped to the next student.** Each package **must** be shipped by the Monday of each Presentation week (2/15, 3/22, and 4/26).

**Pre-Lab questions**

Following the class schedule, each student will submit answers to pre-lab questions for their experiment via Blackboard no later than 12 pm PST of the due date.

**Presentations**

Following the class schedule, the student will present the results of his or her work to the class using PowerPoint or Google Slides. Students are expected to delve deeply into the underlying physics and the results of their experiment. The theoretical section of your presentation should demonstrate a mastery of some portion of relevant theory. The larger experimental section should demonstrate an understanding of how the equipment works, what was measured, how the data were reduced, and how random and systematic errors were estimated. Each oral presentation must discuss motivating theory and experiment; it is not acceptable to discuss only theory or only experiment. The presentation must be submitted to Blackboard by 12 PM PST of the presentation day. The talk will last for 10 minutes, followed by 5 minutes of questions from the class.

**Written reports**

A written report of 4 (or more) typed pages based on the purpose, theory, and results will be submitted for each experiment. Each written report should start with an abstract, briefly mentioning the motivation (purpose), the method (how measured), the quantitative result (with uncertainties), and your conclusions. The bulk of the paper should include a discussion of motivation and the theoretical issues addressed by the experiment, a description of the apparatus and procedures used, a presentation of the results (including errors!), and a discussion of these results. This portion must be accompanied by up to 5 in-line tables and captions (with captions). Finally, the written report should conclude with your conclusions, which reinforces and expands upon the conclusions summarized in your abstract. Each written report will be due Friday following your presentation by 12 PM PST.

**Lab Notebooks**

Each student will keep his or her own lab notebook. Notebooks must be complete and self-contained. All plots, formulas, and conclusions that appear in the student's presentations and written reports must also appear in their lab notebook. Your lab notebook should tell a complete story: What you are trying to do, what you did, what results you obtained, and what conclusions you made. You must write a narrative as the experiment proceeds so that, years later, you could understand the results you obtained and not wonder what you were doing or why you did it. Notes, tables, and graphs should be neat and compact, leaving as little empty space in the lab notebook as is compatible with clarity and the logic of organization. The lines in your notebook are convenient for making tables, and for guiding line drawings and making rough plots.

Analyze data in the lab in a preliminary way as you go along to check for reasonableness. If you are making a series of measurements of one quantity as you vary another, plot the results as you go along so that you can see the trend, catch blunders, and judge where you may need more data. Repeat every important measurement at least three times in as independent a manner as possible to establish a statistical basis for estimating random error and to reduce the chance of blunders. If during class you get through all the manipulations, measurements, and preliminary analysis of an experiment and have extra time, take that opportunity to perfect part or all the experiment to obtain the best possible data set. Lab notebook will be dropped off with the final experiment and will be assessed for clarity and completeness.

**Lab Participation**

Attendance and participation in lab are mandatory, save excused absences and medical emergencies. If a student has submitted both their written report and presentation, participation in days leading up to the presentation week will be excused. Furthermore, lab participation will also factor in timely pick-up/drop-off/mailing of experimental kits to the next student.

**Grading**

| | |
|---|---|
| Pre-lab questions #1/#2/#3 | 5%/5%/5% |
| Written report #1/#2/#3 | 10%/10%/10% |
| Presentation #1/#2/#3 | 5%/5%/5% |
| Lab notebook | 20% |
| Lab participation | 20% |