

# Course Syllabus

## PHYSICS 405 - Spring 2017

### LOCATION/TIME

Wednesday 12:00-1:00 PM

#### For combined lectures (prior to spring break):

- Lecture Room Sections 0101 & 0102: Toll 1204

#### For student presentations (after spring break):

- Lecture Room Section 0101: Toll 1204
- Lecture Room Section 0102: Toll 1201

Laboratory 3112 - Toll Physics Building

### DESCRIPTION

Physics 405 is an advanced undergraduate laboratory course with experiments from many fields of modern physics for physics majors. Students have full access to the experimental equipment and establish their own work schedules and procedures with the guidance of faculty and staff. Emphasis is on independent experiment organization, data acquisition, data analysis, and scientific report preparation.

Students will complete four experiments of their choice from a selection of ten available. You must choose two labs worth two units (longer, more complex labs), and two labs worth one unit (shorter, simpler labs). The number of units assigned to each lab is listed in the introduction of the lab manual.

Students are required to work in pairs. Lab partners must be present in the lab at the same time, so some planning is required to accommodate class schedules. **Partners can use the same data for the analysis and turn in single lab notebook, however, students are required to submit:**

1. **Individual pre-lab questions.**
2. **Individual final analysis of the data. This is pasted into the notebook, so each notebook will have two data analyses.**

Students will be evaluated on the following submitted work:

1. Four lab notebook reports, describing the four completed labs.
2. Four lab notebook checks, one for each lab, to be submitted one week prior to the final notebook due date.
3. Four sets of pre-lab questions.
4. One formal lab report, describing one two-unit experiment in the manner of a research article.
5. One oral presentation.

6. Three homework sets focusing on questions of data analysis, uncertainties, and statistics.

## PREREQUISITE

Physics 375

## INSTRUCTORS

**Section 0101:** Prof. Shabnam Jabeen, [jabeen@umd.edu](mailto:jabeen@umd.edu), 3107 Physical Sciences Complex

**Section 0102:** Prof. Carter Hall, [crhall@umd.edu](mailto:crhall@umd.edu), 2114 Physical Sciences Complex

## TEACHING ASSISTANT

TBA

## LABORATORY STAFF

### Mr. Allen Monroe

301-405-6002

3311 Toll Physics Building

Office Hours: 8 a.m. to 3 p.m. M-F

[amonroe@physics.umd.edu](mailto:amonroe@physics.umd.edu)

### Mr. Thomas Baldwin

301-405-6004

3202 Toll Physics Building

Office Hours: 9 a.m. to 5:30 p.m. M-F

[tbald@physics.umd.edu](mailto:tbald@physics.umd.edu)

## EXPERT TA INSTRUCTIONS



Student code (necessary to purchase access to Expert-TA): USH22MD-751E4F-1FY

Expert-TA registration link: [Expert-TA](#)

## MATHEMATICA TOOLS

- [Integral.nb](#)
- [Analysis.nb](#)
- [FiniteSolidAngle.nb](#)
- [LabReport.nb](#)
- [LinReg.nb](#)

## READING MATERIAL

- [Systematic Uncertainties: scale and offset](#) 
- [A guide to data analysis - based on Lyons Book.pdf](#) 

## REQUIRED REFERENCE

- **Physics 405 Laboratory Manual** – Department of Physics, Fall 2016 edition. This is available for purchase electronically on Expert-TA. It is not available in print, however you may print it yourself.

## SUGGESTED REFERENCES

- **Data Reduction and Error Analysis for the Physical Sciences** - Phillip R. Bevington and D. Keith Robinson (McGraw Hill, Inc., 2003, [ISBN 0-07-247227-8](#))
- **An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurement** – John R. Taylor (University Science Books, 1997, [ISBN 0-935702-75-X](#))
- **Practical Guide to data analysis for physical sciences students** - Louis Lyons. (ISBN-13: 978-0415481519).
- **Building Scientific Apparatus** – J. H. Moore, C. C. Davis, and M. A. Coplan (Cambridge University Press, Fourth Edition, 2009, [ISBN 978-0-521-87858-6](#))

Two (2) laboratory notebooks are required so that one is available for laboratory work while the other is being graded. Notebooks are to be 8.5" x 11" or larger, with bound, numbered, quad-ruled pages that are permanent and unperforated.

## ATTENDANCE

You must attend lecture each Wednesday at noon, and attendance will be recored. Failure to attend lecture will result in a loss of credit for your final grade. Students must be attentive during class, including during the student presentations, or otherwise it will be counted as an absence.

## LAB NOTEBOOK REPORTS

You will report your experimental findings primarily by submitting your laboratory notebooks for grading. **Partners can use single notebook to record their experimental observations and results, but each should write final data analysis individually.** The two final data analyses should be taped into the logbook and submitted with it at the end of each lab.

Your notebooks should consist of:

1. A time-ordered record of your activities while in the lab room. **Each time you make an entry in your lab notebook, write the time current time.** At the end of a lab period, it should be possible to reconstruct in some detail exactly how your time in lab was spent by reading the notebook. It is not necessary to copy in detail the information contained in the lab instructions into your notebook, although in most cases a diagram and description of your experimental setup (e.g., how you have configured the cables and knobs) is necessary to provide context to

the data that you are recording. (This portion of the notebook can be the same for both partners.)

2. An analysis of your data, where you extract the physical quantities of interest in each experiment, **and with a focus on the systematic and statistical uncertainties.** (Each lab partner must write this individually.)

It is expected that most of the in-lab portion of your notebook will be neatly handwritten. **You must write neatly in order to receive a passing grade.** You will also need to include print-outs of plots, figures, tables, and other forms of data that you create or analyze with a computer. These may be included by taping or stapling them into your notebook.

The final data analysis should be typed and pasted in the lab-notebooks. Partners will share the in-class portion of the notebook, and partners are welcome to work together on the analysis of the data. **Nevertheless, each student must write their own short report on the final analysis of the data and tape it into the shared notebook.** This means that you and your partner must share the notebook outside of class.

You have three weeks to complete each lab. Notebook reports are due in class on Wednesday every third week (see schedule below). Your graded notebook reports will be returned to you one week later.

Notebook reports will be graded according to the following formula:

- 50% for completeness and effort
- 50% for data analysis and discussion of systematic and statistical uncertainties

**There is a 10% penalty, per day, for late notebook reports.**

**Note that some labs are more complex and lengthy than others.** The longer labs are worth two units, while the shorter ones are worth one unit. You must choose to complete two of each type. Keep in mind that the two unit labs are likely to require additional time in lab.

## LAB NOTEBOOK CHECKS

In addition to submitting your lab notebook report at the end of each lab, **you will also submit your notebook in class for grading one week prior to the final notebook report due date.** Your instructors will check to make sure that you are making adequate progress on the lab, and that you have made a first attempt to collect all the data from the lab. We also expect that your graded pre-lab questions will be taped into the logbook by this time. It is understood that your data will not be finalized and will not be of the highest quality when you submit your notebook at this time.

Your notebooks will be returned to you by placing them in the lab room no later than 24 hours after submission. You will then complete the lab and submit your notebook report the following week.

Your notebook will not be graded in detail at this time, but will be graded according to the following formula:

- 33% for completeness: making an initial attempt at the entire lab
- 33% for keeping a good record of time in lab, including time stamps, neatness, and legibility.
- 33% for briefly describing, with a short paragraph, the most important systematic uncertainty that will be present in the final notebook report, and with an initial estimate of its size (either absolute or percentage).

There is a 10% penalty, per day, for late notebooks.













## PRE-LAB QUESTIONS

**Before entering the lab for the first time**, you must carefully read the lab instructions and complete the pre-lab questions **on paper**. You must bring your completed pre-lab questions with you when you enter lab during the first week. Your instructors and TA will ask to see them and will collect them. If your pre-lab questions are not collected in lab during the first week, then bring them to the lecture on Wednesday for collection (see schedule below). **While you may work together, each student must complete and submit their own pre-lab questions independently.**

## FORMAL REPORT (RESEARCH ARTICLE)

One formal report or research-style article on the second experiment is required and is to be submitted in lecture on May 3, 2017. See the schedule below. The format of the formal report is given in the laboratory manual and on ELMS. **You must choose one of the two-unit labs for your formal report.**

## FORMAT EXAMPLES FOR THE FORMAL REPORT

1. [A closer look at tumbling toast](#)  
2. [One-dimensional laser cooling of an atomic beam in a sealed vapor cell](#)  
3. [Measurements of the horizontal coefficient of restitution for a superball and a tennis ball](#)  
4. [A simple experiment for measuring the surface tension of soap solutions](#)  
5. [Demonstration of surface plasmons in metal island films and the effect of the surrounding medium—An undergraduate experiment](#)  
6. [Ferroelectricity: Measurement of the dielectric susceptibility of strontium titanate at low temperatures](#)  

## ORAL PRESENTATION

Each student is required to give one 12-minute presentation. **The presentation will describe one of the two-unit experiments, or, with permission, on the student's own research.** The talks will be followed by questions from students, the instructors, and TA. (3 minutes for questions). You will prepare slides for your talks as google slides, and a talk template will be provided to you by your instructors. These oral presentations will begin after spring break (see schedule below).

Students are required to attend all the student presentations and be attentive. For this portion of the semester, we will divide the class into the two sections (0101 and 0102) and meet separately, so that everyone has a chance to present once.

## HOMEWORK

During the semester homework problems will be assigned. The purpose of these problems is to review and strengthen understanding of error analysis that will be used in the interpretation of data, as well as provide experience with experimental topics.

## GRADES

Prelab questions (1st week)	10%
Notebook checks (2nd week)	10%
Notebook reports (3rd week)	40%
Homework	5%
Formal Report (on one experiment with two units)	20%
Oral Presentation	15%
<b>Total</b>	<b>100%</b>

## SCHEDULING EXPERIMENTS

There is an online sign-up sheet that can be accessed from any computer with an internet connection or from the computer in Rm. 3210. The url is <http://www.physics.umd.edu/cgi-script/courses/p405.pl>.

Work on the experiments must be formally scheduled. Time slots are available in half-day periods. In order to save an experimental setup, two consecutive periods must be reserved. When an experiment has been completed and data acquisition finished the experiment must be dismantled.

Keep in mind that prior to carrying out an experiment, the pre-lab questions must be answered on paper. Your instructors and the TA will occasionally stop by the lab and will ask to see your pre-lab questions.

## LAB SCHEDULE

The laboratories are open Monday through Thursday from 9:00 a.m. - 5:00 p.m. and on Friday from 9:00 a.m. to 4:00 p.m.; The last person to leave a laboratory must close the door.; When returning to a laboratory, Mr. Monroe or Mr. Baldwin will open the door again.; Work is to be finished at the end of the laboratory period.; If data acquisition is not complete at 5:00 p.m. and the experiment is reserved for the following day, a note should be left on the experiment to avoid its being disassembled.

Instructor and Teaching Assistant laboratory hours will be announced in class and posted in the laboratory and on the course web site (ELMS).

## LAB CADENCE

- **Week one** (Wednesday to Wednesday)
  - Read the lab instructions.
  - Complete the prelab questions on paper, and bring them to lab with you. Your TA and instructors will ask to see them.
  - Sign up for a time to come to the lab with your partner and familiarize yourself with the equipment.
  - **Turn in your pre-lab question in the next lecture if it has not already been collected by the instructors or TA during the week.**
- **Week two** (Wednesday to Wednesday)
  - Make an attempt to collect data from all portions of the lab.
  - Make an initial estimate of the primary systematic uncertainty in the experiment and write a description of it in your notebook.
  - **Turn in your notebook for the notebook check in lecture at the end of the week. Retrieve your notebook from the lab room the following day.**
- **Week three** (Wednesday to Wednesday)
  - Repeat all portions of the lab with the aim of collecting your final and best data.
  - Analyze your data and write your report in your notebook.
  - **Turn in your notebook in lecture at the end of the week.**

## 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 including equipment diagrams, measurement configurations, results, estimates of errors and limitations to the measurements, analysis used to obtain final results and a proper estimate of all errors including systematic as well as statistical errors. 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 and on Expert-TA. 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!

## VALID EXCUSES

If you have a valid excuse for missing a due date for a notebook report or a 12-minute presentation (e.g. a medical emergency) see one of the Professors to make alternate arrangements, beforehand. *Ex post facto* (after the fact) excuses will require validation and may not be acceptable. You must speak to one of the Professors. The TA does not have the authority to make alternate arrangements.

## ACADEMIC INTEGRITY AND OTHER UNIVERSITY POLICIES:

All university policies regarding student rights and obligations, including academic integrity (cheating), are available at: <http://www.ugst.umd.edu/courserelatedpolicies.html>

## IMPORTANT DATES

- First meeting: Wednesday, Jan. 25th - Introduction to the Laboratory
- Research Article due: May 3rd.
- Last lecture class: May 10

## SCHEDULE

Tentative schedule - Check course website for updates.

Physics 405 - Spring 2017 - Profs. Jabeen and Hall

Week	Date	Lecture Topics	Lecturer	HW	Lab	Due
1	25-Jan	Introduction	Hall/Jabeen			
2	1-Feb	Radiation safety	staff		1	Prelab Questions 1
3	8-Feb	Vacuum technology	staff	HW1	1	Notebook 1 check
4	15-Feb	Statistics, uncertainties	Hall/Jabeen		1 & 2	Notebook 1 due
5	22-Feb	Statistics, uncertainties	Hall/Jabeen	HW2	2	Prelab Questions 2
6	1-Mar	Statistics, uncertainties	Hall/Jabeen	HW3	2	Notebook 2 check
7	8-Mar	Statistics, uncertainties	Jabeen		2 & 3	Notebook 2 due
8	15-Mar	Statistics, uncertainties	Jabeen		3	Prelab Questions 3
	22-Mar	Spring Break				
9	29-Mar	Presentations			3	Notebook 3 check
10	5-Apr	Presentations			3 & 4	Notebook 3 due
11	12-Apr	Presentations			4	Prelab Questions 4
12	19-Apr	Presentations			4	Notebook 4 check
13	26-Apr	Presentations			4	Notebook 4 due
14	3-May	Presentations				Research Article
15	10-May	Presentations				