Physics 251 - Syllabus, Fall 2020

1 Instructors and TAs.

- Instructors: Eugeniy E. Mikhailov (Wednesday and Thursday afternoons), Irina Novikova (Thursday morning)
- TAs: Ben Skopic, Carlos Pernas
- Web: http://physics.wm.edu/~evmik/classes/2020_fall_Experimental_Atomic_Physics_251/ all class materials and announcements will be posted here.

2 Course objectives.

- Learn to make connection between theoretical ideas and formulas and their implementations in experiments
- Become familiar with the basic lab equipment and the concept of equipment calibration
- Master data acquisition and processing technique, as well as the error analysis
- Become familiar with the iterative approach to improved measurements through intermediate analysis and identifying most important error sources.
- Learn to reporting experimental results through lab reports and a final presentation
- Acquire basic skills of working with specialized software for data analysis and scientific publishing

3 What will we do.

The course will focus on performing the experiments, analyzing the data and preparing the lab reports. On average, each lab will stretch over two weeks, and will include several steps

- **Pre-lab prep.** No scientists starts an experiment without deciding what they are testing. Even if they don't know the results, they know what question they ask. Thus, it is required for all students to familiarize themselves with the theoretical concepts and experimental approaches before the class period by studying the manual and other provided materials. Students are required to **complete and submit a pre-lab assignment at least 24 hours before the beginning of each new lab**.
- **First period: apparatus assembly and data taking.** Each student will be assign a lab to work on for each week. Due to the social distancing restrictions only one person will be working on one experimental apparatus. Students are required to bring their own computer and a notebook for keeping the records. At the end of this first meeting it is expected that all students collect all the necessary data and verify them with the instructor or TA.
- **Preliminary data verifications.** Things go wrong sometimes, and there is always a possibility that there are problems with the collected data that cannot be found before the data are analyzed or plotted. Therefore, it will be crucial that before the second period of the lab each student perform a preliminary checks of their data. In fact, it is the best to do it at the end of the first period, when the instructor or TA are available

to help. This will allow students to retake any problematic data sets or collect missing information.

- **Second period: data analysis, error analysis and report preparation.** Taking data is only a half of the process (often even less than a half)! So the second period will be devoted to to the preparation of the lab report. That will include making presentation-quality graphs, performing proper error analysis, and preparing the draft of the lab report.
- **Report submission.** While we encourage you to complete as much of the report as possible during the second period, to take the full advantage of the available help and advice, the final report is due the beginning of the next lab (see submission instructions below).

3.1 Keeping the notes in a log book.

Your lab book should be any regular style notebook (**without rings** or other means to discretely remove or add pages) with either line or quadrangle ruling or a computation log/lab book. Alternatively, you can use an electronic notebook - but discuss it with the instructor first.

The log book is the main source of information about the experiment when you are outside the lab, so it is very important to maintain it well, and include as much experimental information as possible, especially if it impossible to recover it without recreating the experiment. Typical lab book contains neat notes or tables with all the raw data, all other relevant experimental parameters that are needed for the data analysis, notes on your experimental methodology, calculations, etc. Everything you do goes into this book and it provides the foundation for your lab reports. You need to bring it every week (if you forget, you will have to run home to get it).

Diagrams, data, graphs, and other notes on separate pieces of paper should be glued, taped, or stapled into the lab book. If something falls out of the lab book during reading/shaking/transporting, it is not the part of the log book and will be discarded. All notes should be written in **pen**. Mistakes and errors in design, data, and analysis will occur, and they should be crossed out neatly.

You should enter you lab notes and data directly into the lab book. A 'scratch' lab book that is neatly copied into the lab book at a later time is a waste of time and often a bad practice. All the information in the log book should be readable - but it does not have to be pretty to look at.

3.2 Lab reports.

You will need to write a report for each of the standard labs. **Lab reports are due at the start of the class following the lab completion, unless stated otherwise**. The reports will be submitted electronically. The submission instructions will be provided soon.

Late reports will be docked 5% per day, unless you obtain the instructor permission **before** the deadline.

In physics and mathematics LaTeX is the standard program used to format papers. It is great, especially for mathematical formulae, figures with captions, and tables. It is available on Windows/Mac/Linux. A previous student says:

> Just letting you know I used LaTeX using TeXnicCenter as my editor. At first I was a bit skeptical because I felt Word could do just as much without having to build the Document to view it. But as experiments began to need more figures and equations I really started to enjoy latex because it was so simple. I could make gigantic equations like the Schrodinger's equation in just a minute whereas word would have taken me quite a while. Anyways I'm really happy I learned to use LaTeX and look forward to using it in the future.

We **require** you to use LaTeX for report preparation. The lab report sample and LaTeX template are provided at the class web site. There are also pointers on how to install or use online version of LaTeX.

The use of the 'office' software, such as MS Office, OpenOffice, LibreOffice, etc., is not allowed. These editors are not designed for scientific writing, especially for entering equations. Thus, unless special templates and macroses are used, the resulting product does not look good.

3.3 Special project.

During the last two weeks each students will be working on a special research project that requires more independence than the previous labs, and allows the students to apply all the developed experimental skills. The details about this project will be shared later in the semester (when we hopefully have better idea of how the end of the semester is going to look like). The special project will require both lab report and a presentation. There will be no other final examinations in this course.

3.4 Data analysis software.

It might be tempting to use MS Excel for you analysis, but it is not adequate for scientific data analysis, especially later in the course. Thus, we **request you to keep away** from Excel and similar office tools.

The instructors will provide help on using Matlab which is very powerful and free for W&M students. Also have a look at our class web site for matlab basics. However, anyone who has good proficiency in other programming languages, such as python, are welcome to use it (unfortunately, the instructors' expertise with it is very limited).

Usually there is no 'silver bullet' software which does good analysis and presentation, and you might invest some time to find a good plotting software as well.

3.5 What to bring in class.

Bring your laptop with analysis software satisfying above requirements. **Do not bring your calculators**. If I spot you with it, points will be taken. "Do not ride a bicycle if you have the starship Enterprise in your possession".

Bring your logbook and pen, this goes without saying. It maybe also a good idea to have your phone or tablet to take pictures or videos, if necessary.

Everything else will be provided.

3.6 Lab rules.

3.6.1 General lab safety rules.

No food or drinks are allowed.

Check all your electrical connections before powering the equipment, especially if the experiment involves high voltage.

Be careful with the lab equipment and handle it with care: almost any piece of equipment is hard to fix or replace. Please let the instructor or TA know if there is any problem with the equipment, either by your own doing or by someone else's.

Avoid touching any transparent surfaces of any optical component. A worthless looking pieces of glass may actually cost more than your smartphone, and a simple fingerprint can ruin them. If you did touch it by accident, notify the instructor or TA right away, so that the piece can be cleaned.

3.6.2 COVID-related safety rules.

To comply with social distancing requirements each student will be working on a single table, following the marked seating pattern. Please avoid gathering inside or outside the lab. If you see the instructor/TA talking to someone already, please wait to approach them until the conversation is over, and the other person has returned to their seat.

Disinfecting wipes will be provided, but feel free to bring your own PPE if desired. The pre- and post-lab cleaning procedures will be available in the classroom.

Proper mask wearing will be required and enforced.

4 COVID related measures.

4.1 Possible switch to on-line instructions.

In case any of the class meetings has to be on-line, the class will meet at the assigned time period via Zoom (the link will be provided), and the attendance is required. While the hand-on data taking will be impossible, some means of engagements will be provided depending on each lab. For example, the very first lab (conducted on-line during the first two weeks of classes) will use only things available at home. For some labs some raw data will be provided by TAs, and students will be performing all the necessary data analysis.

If the classes are in-person, but an individual student needs to quarantine, they are required to contact the instructor ASAP, so that specific arrangements can be made.

4.2 The missing week recovery.

Due to the COVID, Fall 2020 semester is shortened by one week. To compensate for the missing time, we will provide about 2 hours of video tutorials. They will cover use MATLAB, equipment, etc.

5 Physics 201 corequisite.

Physics 201 is a corequisite of this class. However, unlike Physics 101/102, the two classes are separate and we do not try very hard to keep them in sync or make sure that 201 covers the theory behind a topic before 251 does the experiment. This is, more or less, how progress in physics really occurs! Experimenters usually do their work at the frontier where there is no theory or where there are multiple competing theories.

6 Evaluations.

Your final grade for the course will be determined from the following grading weight distribution:

Lab reports	Special project	Pre-lab evaluations	Lab participation
60%	25%	10%	5%

In order to pass the class, you must complete and turn in a report for **every lab** and complete (and report on) the special project. Makeup labs are only allowed with prior permission and for a good reason or due to illness. Unlike 101/102 labs there is no reserved date. We will just deal with this as necessary.

7 Grading.

Grade	Score percentage	Grade	Score percentage	Grade	Score percentage
		A	94-100	A-	90-94
B+	87-90	B	84-87	B-	80-84
C+	77-80	C	74-77	C-	70-74
D+	67-70	D	64-67	D-	60-64
F	<60				

7.1 Final exam.

There is no final exam. The final presentations will take place during the time slot assigned for the final exam.