Physics 2225 – Physics Lab II for Scientists & Engineers
Fall Semester 2019
Section 001: Tuesdays 9:40am-12:40pm JFB 104
Section 002: Tuesdays 12:55pm-3:55pm JFB 104
Section 003: Tuesdays 4:10pm-7:10pm JFB 104
Section 004: Wednesdays 9:40am-12:40pm JFB 104

Instructor:  Gernot Laicher
Email: gernot@physics.utah.edu
Phone Number: 801-585-5553
Office Hours: M 3m-4pm, F 1pm-2pm (check Canvas for potential changes) or by appointment
Office Location: Physics Building room 410 (Building 10)
Email communication preferred.

Section Teaching and Learning Assistants:
Lab sections will have assigned teaching assistants (TA) and learning assistants (LA) - if available. The name, contact information and the TA/LA office hours will be published on Canvas. The lab TA also grades pre-lab assignments, post-lab assignments, and lab reports.

Required Materials
Physics 2225 will use MATLAB (software) for computational tasks. MATLAB will be installed on the lab computers. Students are also required to either purchase a copy of MATLAB (currently students can purchase MATLAB for $30 through the Office of Software Licensing [https://software.utah.edu/]) or have access to a computer with MATLAB to be able to complete assignments that require MATLAB use. There are many student accessible computers on Canvas which have MATLAB installed, so having a personal copy of MATLAB is not mandatory. However, many students may find that having a personal copy makes completion of assignments more convenient.
Instructional material will be provided through Canvas.
Laboratory equipment/material is provided.

Course Description
Continuation of PHYS 2215. laboratory designed to accompany PHYS 2220. The course teaches laboratory skills needed by scientists and engineers. Topics include measurement, data analysis, computer graphics display, experimental design and report writing, experiential procedures and results. Students will make experiments in standing waves, sounds, electric circuits, electronic instrumentation, optics and modern physics. Physics 2225 is a 1 credit hour course.
Prerequisites: C- or better in PHYS 2215.
Corequisites: C- or better in (PHYS 2220 OR PHYS 3220) OR AP Physics C E &M score of at least 4.
Course Outcomes
By the end of this course, you will be able to:

- Critically think through, design and implement experimental procedures, perform and analyze measurements, create mathematical models, and write lab reports.
- Present measured and calculated data and their uncertainties with proper number of significant figures.
- Understand the mathematics of error propagation and perform error propagation using symbolic variables and partial derivative functions on MATLAB.
- Explain your lab activity, communicate your results, analyze your data, draw conclusions in lab reports written as MATLAB live scripts, which include mixed text, figures, and MATLAB code.
- Know the basics of coding in MATLAB and know how to independently continue using and expanding your MATLAB proficiency.
- Solve systems of equations with several unknowns using MATLAB.
- Perform linear regression analysis both with and without weighting from uncertainties, interpret the statistic of the regression analysis, and evaluate the goodness of the fit.
- Predict the results of heat transfer between objects based on their heat capacities and temperatures.
- Use the principles of cross-correlation to analyze time-shifts of sound signals.
- Know how to properly use common laboratory instrumentation such as oscilloscopes, digital multi-meters, function generators and breadboards.
- Build basic circuits and circuit elements, perform voltage and current measurements, and measure the time constant of an RC circuit.
- Write a lab report in the basic form of a scientific paper.
- Describe mathematically the location of single and double slit interference maxima and minima and use these to measure the wavelength of a Helium-Neon laser.
- Measure and model with MATLAB the light intensity of a point source and an extended light source as a function of distance.
- Understand the basic principles of transmission grating spectroscopy and analyze light source spectra through wavelength measurements.
- Experimentally determine the charge-to-mass ratio of an electron.
- Experimentally determine the earth’s magnetic field strength using a compass, bar magnet, and a stop watch.

Teaching and Learning Methods
In Physics 2225 you will practically explore the physics of waves, sound, heat, electricity, magnetism, and optics in three-hour lab activities done in groups of two to three students. The main learning objectives are to enhance the ability to critically think through laboratory processes, design needed details of setup and analysis, perform measurements and experiments, do mathematical modeling with MATLAB, and communicate objectives, procedures, analysis, and results in a logical and clear form.

While deepening the understanding of the laws of physics, you will also learn many practical laboratory skills in this course such as the use of basic measuring devices,
estimation and propagation of uncertainty, statistical and graphical analysis, as well as basic troubleshooting of equipment should the apparatus not function as planned. In addition, the laboratory group experience allows you to exercise soft skills such as critical thinking, team work, discussion, and cooperation.

The objective of the pre-lab assignments is to refresh memory of the basic principles learned in Physics 2220 in as far as they are needed in the upcoming lab activity and to introduce you to and have you practice data processing and other common lab techniques that will be used in the lab activities. You will have 3 attempts to get pre-lab quizzes right. We hope that all students will get the correct answers with 3 attempts and thus come to the lab activity with certain concepts already clarified.

University Policies

1. The Americans with Disabilities Act. The University of Utah seeks to provide equal access to its programs, services, and activities for people with disabilities. If you will need accommodations in this class, reasonable prior notice needs to be given to the Center for Disability Services, 162 Olpin Union Building, (801) 581-5020. CDS will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in an alternative format with prior notification to the Center for Disability Services.

2. University Safety Statement. The University of Utah values the safety of all campus community members. To report suspicious activity or to request a courtesy escort, call campus police at 801-585-COPS (801-585-2677). You will receive important emergency alerts and safety messages regarding campus safety via text message. For more information regarding safety and to view available training resources, including helpful videos, visit safeu.utah.edu.

3. Addressing Sexual Misconduct. Title IX makes it clear that violence and harassment based on sex and gender (which includes sexual orientation and gender identity/expression) is a civil rights offense subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, color, religion, age, status as a person with a disability, veteran’s status or genetic information. If you or someone you know has been harassed or assaulted, you are encouraged to report it to the Title IX Coordinator in the Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, or the Office of the Dean of Students, 270 Union Building, 801-581-7066. For support and confidential consultation, contact the Center for Student Wellness, 426 SSB, 801-581-7776. To report to the police, contact the Department of Public Safety, 801-585-2677 (COPS).

4. Diversity / Inclusivity Statement. It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students’ learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. It is my intent to present materials and activities that are respectful of diversity: gender, sexuality,
disability, age, socioeconomic status, ethnicity, race, and culture. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally or for other students or student groups. In addition, if any of our class meetings conflict with your religious events, please let me know so that we can make arrangements for you. (Source: University of Iowa College of Education)

5. **Undocumented Student Support Statement.** Immigration is a complex phenomenon with broad impact—those who are directly affected by it, as well as those who are indirectly affected by their relationships with family members, friends, and loved ones. If your immigration status presents obstacles to engaging in specific activities or fulfilling specific course criteria, confidential arrangements may be requested from the Dream Center. Arrangements with the Dream Center will not jeopardize your student status, your financial aid, or any other part of your residence. The Dream Center offers a wide range of resources to support undocumented students (with and without DACA) as well as students from mixed-status families. To learn more, please contact the Dream Center at 801.213.3697 or visit dream.utah.edu.

6. **Student Code and Accommodation Policy:**
   a. Student Code: [http://regulations.utah.edu/academics/6-400.php](http://regulations.utah.edu/academics/6-400.php)
   b. Accommodation Policy (see Section Q): [http://regulations.utah.edu/academics/6-100.php](http://regulations.utah.edu/academics/6-100.php)

**Course Policies**

**Preparation:** In preparation for an upcoming lab activity, you are expected to do the following at home:

1. Do the pre-lab activities due for the upcoming lab.
2. Refresh your knowledge of the relevant Physics topics by reading/studying a suitable Physics textbook.
3. Contact your TA (or any other TA teaching another section of the same course) by e-mail, through Canvas, or during office hours regarding questions on pre-lab assignments or about questions regarding the Physics subject matter.

**Structure of Lab Activity:**

1. The TA/Instructor will briefly discuss the lab activity at the start of every lab session, so be sure to be on time.
2. The lab work will follow the initial discussion and will be performed in groups of two or three students. All group members are expected to actively participate in the lab activity, recording data, evaluating data, discussing findings, and writing of the lab report.
3. You will be expected to take turns in your roles. That means, it should not always be the same person who sits on the computer etc. When writing code for MATLAB, it is important to not have one person sit at the computer, come up with the code and write the code. A good practice is to have one person type code but the code must be
dictated by a person not sitting at the computer. This practice ensures that both “typist” (who can slow down the process if he/she doesn’t understand the code) and “non-typist” are gaining insight in the code structure. The roles ideally are rotated. If not rotated, the person with the least experience in coding should preferably be the person typing.

4. The lab TA will be available to facilitate your explorations. It is NOT the role of the TA to tell you whether your result is correct. The TA can help you asking yourself (or your group) the right questions that help facilitate your progress and critical thinking. The TA may also be able to help you with proper use of equipment and troubleshooting.

5. **LAs** are not involved in the grading of your assignments. Their role is mainly to facilitate productive and inclusive interaction among students.

6. Lab reports must be submitted by each group through Canvas. The names of the participating students must be written into this lab write-up. Many (perhaps all) lab reports will need to be written as a MATLAB live script so that you can embed your code into the lab report.

**Attendance & Punctuality:** You are expected to be in the lab room at the start of the lab activity. The activities are group activities. If you arrive late, you may not be able to join a group which already has started the lab activity.

**Participation:** To get credit for a lab activity, attendance is required. Writing of a lab report is not sufficient to get credit for the lab. You must be present and **actively participate** in the lab activity.

**Food and Drink:** It is often not safe to consume food or drinks in laboratories due to the presence of substances in labs which may not be safe when ingested. Potentially harmful substances may be on your hands, be then transferred to your food and thus be unknowingly ingested. If hunger or thirst occurs during the laboratory class, please seek out a restroom, wash your hands thoroughly, and then consume food/drink in the hallway outside of the lab room. There are benches where you can sit.

**Laboratory Safety:** Follow all safety instructions provided on Canvas or communicated by the instructor/TA in class. Closed shoes are highly recommended. We do not use aggressive chemicals in this lab, but you will be handling equipment (such as metal masses), which could potentially injure your feet if dropped on them.

**Electronic Devices in Class:** Please turn your cell phone ringers off during the lab class. If you receive an urgent phone call, please step outside into the hallway to minimize disturbance to other students.

Tablets and laptops are not required but can be quite useful to bring to this class. We may even use some Apps on cell phones to perform measurements, take pictures of setups, or take a video to analyze.
Canvas: This class uses Canvas. Much of the instructional material will be deposited and available there. Lab reports will be submitted and graded through Canvas.

Assignments: Assignments will be provided through Canvas

Missing a Lab / Making up a Missed Lab:
1. Labs which were missed due to participation in University-sponsored activities (e.g., if you are a member of a University athletic team and had to be at a competition during your lab time) can all be made up per university policy. Please contact the lab director in such circumstances and provide him with advance notice (at least 1 week in advance) of your absence so that proper arrangements for making up the missed lab can be made.
2. The general rule is that you must attend the lab section you are signed up for.
3. Severe circumstances: If you feel that severe circumstances are causing you to miss a lab activity, please contact the lab director. He will hear your case, discuss your options, and may grant permission to attend another lab section.
4. The lab director may allow some students with valid excuses an opportunity to make up a missed lab activity.
5. If time allows, a makeup lab session will be scheduled in the last (or second to last) week of classes (during regular lab hours).

Procedure for Disputing a Received Grade: Any grievances about received grades should initially be addressed to the TA in charge of grading. Please explain to the TA in detail where and why you disagree with his/her grading. In cases in which you and the TA are not able to resolve the dispute about the grading, please contact the lab director for further advice. The lab director will make a final decision on the case after consulting both the TA and the student about the matter. The lab director may request that both the TA and the student meet with him in his office to discuss the issue.

Questions regarding the final grade received in the class should be addressed directly to the lab director.

Grading Policy (Evaluation Methods & Criteria):
Physics 2225 is a graded one credit hour course. Grades of A, B, C, D, and E will be assigned on the basis of your performance in the course.

Pre-lab quizzes and assignments will have varying number of points. They typically are less than 5 points. Many, but not all labs may have a graded pre-lab and post-lab quiz/assignment.

There will be some “Surveys”, which help the lab director stay informed about things like the general level of programming experience in the class or feedback on lab activities. In surveys you are simply being asked to participate. They are not “graded” because there is no “right or wrong” answer. However, you will be given a small amount of points (1 or 2 points perhaps) for simply participating – no matter what your survey answers are. Lab
reports count 20 points per week of lab activity. The lab report for the e/m experiment counts 30 points.

The final grade you receive is determined by the number of points achieved from pre- and post-lab assignments/quizzes, surveys, and lab reports. The grade scale is as follows:

- 92% (or more) = A
- 87% - 91% = A-
- 82% - 86% = B+
- 77% - 81% = B
- 72% - 76% = B-
- 67% - 71% = C+
- 62% - 66% = C
- 57% - 61% = C-
- 52% - 56% = D+
- 47% - 51% = D
- 42% - 46% = D-
- 41% (or less) = E

Final percentages are rounded: For example, 81.4% is rounded down to 81% (B). 81.5% is rounded up to 82% (B+).

The lab director will evaluate the lab report averages of all TAs (TAs are responsible for grading) to identify whether systematic and significant deviations in grading “harshness” exists between TAs. Scores of lab reports in sections with TAs that tend to grade more strictly will be adjusted upward to match scores of the more leniently grading TAs. Please note: These adjustments will never lower your grade compared to the scale above, but they may in some cases lift up your grade slightly.

**Course Schedule**

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<thead>
<tr>
<th>Date</th>
<th>Topic/Discussion</th>
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<tbody>
<tr>
<td><strong>Week 1:</strong></td>
<td></td>
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<tr>
<td>Tue Aug 20</td>
<td>No lab activity</td>
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<tr>
<td>Wed Aug 21</td>
<td>No lab activity</td>
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<tr>
<td><strong>Week 2:</strong></td>
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<tr>
<td>Tue Aug 27</td>
<td>Lab 0: MATLAB Practice</td>
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<tr>
<td>Wed Aug 28</td>
<td>Lab 0: MATLAB Practice</td>
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<td><strong>Week 3:</strong></td>
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<tr>
<td>Tue Sep 3</td>
<td>Lab 1: Standing Waves</td>
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<td>Wed Sep 4</td>
<td>Lab 1: Standing Waves</td>
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Week 4:
Tue Sep 10  Lab 2: Sound
Wed Sep 11  Lab 2: Sound

Week 5:
Tue Sep 17  Lab 3: Heat and Temperature
Wed Sep 18  Lab 3: Heat and Temperature

Week 6:
Tue Sep 24  Lab 4: Optics 1
Wed Sep 25  Lab 4: Optics 1

Week 7:
Tue Oct 1   Lab 5: Optics 2
Wed Oct 2   Lab 5: Optics 2

Week 8:
Tue Oct 8   No Lab (Fall Break)
Wed Oct 9   No Lab (Fall Break)

Week 9:
Tue Oct 15  Lab 6: Working with Electronic Equipment
Wed Oct 16  Lab 6: Working with Electronic Equipment

Week 10:
Tue Oct 22  Lab 7: RC Circuits
Wed Oct 23  Lab 7: RC Circuits

Week 11:
Tue Oct 29  Lab 8: Magnetic Fields
Wed Oct 30  Lab 8: Magnetic Fields

Week 12:
Tue Nov 5   Exp 1: E/left mright Experiment
Wed Nov 6   Exp 1: E/left mright Experiment

Week 13:
Tue Nov 12  Lab 9: Faraday’s Law
Wed Nov 13  Lab 9: Faraday’s Law

Week 14:
Tue Nov 19  Lab 10: Optics 3
Wed Nov 20  Lab 10: Optics 3
Week 15:
Tue Nov 26    Lab 11: Spectrometer
Wed Nov 27    Lab 11: Spectrometer

Week 16:
Tue Dec 3     Time to make up a missed lab
Wed Dec 4     Time to make up a missed lab

Finals Week:
Please note that Physics 2225 has no final exam.

Note: This syllabus is meant to serve as an outline and guide for our course. Please note that I may modify it with reasonable notice to you. I may also modify the Course Schedule to accommodate the needs of our class. Any changes will be announced in class and posted on Canvas under Announcements.