Syllabus

PHYS 6775 - Optical Measurement Techniques and Instrumentation Laboratory
(OMTI Lab)

Instructor:
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Email: gernot@physics.utah.edu
Office hours: M 3pm-4pm, F 1pm-2pm (check Canvas and Website to verify)

Laboratory room: Physics Building (building 10) room 305

The OMTI lab meets in the physics building (the building with the astronomical observatory on top) in room 305.

Meeting time:

The OMTI lab uses expensive equipment, allowing only one group of students to perform a lab activity at a time. The class will therefore be split into up to 4 lab groups (2-3 students per lab group). Each lab group will have their weekly lab time arranged based on student and instructor availability. The weekly lab time is 4 hours per group. Each group will meet with the instructor during their assigned time to perform the lab activity.

Participation:

Students enrolled in this class are expected to attend their weekly 4 hour long laboratory section and are expected to be on time. Students need to be willing communicate and participate with other group members. Each group member needs to be engaged in the lab activity. It is important that each group member participates in equipment setup and adjustment, planning and execution of data acquisition, and discussion with other group members and the instructor.

Online Access (Canvas):

All pre-lab and lab assignments as well as additional helpful material will be provided through Canvas modules. Pre-lab quizzes and assignments and lab reports are performed on or submitted through Canvas as well. Canvas also provides a convenient venue to interact with other group members and the instructor outside of lab time. Canvas can be accessed here:

https://go.utah.edu/cas/login?service=https%3A%2F%2Futah.instructure.com%2Flogin%2Fcas
**Representative Textbook(s):**
Laboratory instructions will be provided by the instructor through Canvas. Optional textbooks are the same as suggested for Physics 6770, the lecture portion for this course.

**General Description of Course:**

The purpose of this laboratory class is to teach students the use and operation of optical equipment and to apply theoretical knowledge acquired in the PHYS 6770 lecture. Physics 6770 and 6775 is for advanced students who have already completed at least a general physics lab and therefore have some prior basic optics (reflection, refraction, diffraction, interference, etc.) laboratory experience. During the semester seven experiments which last between one and two weeks are performed in small groups. The laboratories are designed to introduce students to equipment and measurement techniques commonly used in scientific research involving optics. Emphasis is placed on critically assessing the capabilities and limitations of the devices and techniques to ensure proper measurements and data analysis. Among the equipment used for these experiments are: Photodetectors, lasers, interferometers, acousto-optic modulators, ellipsometers, optical spectoscopes, and lock-in amplifiers.

**Pre- and Co-requisites:**

Co-requisite: Physics 6770 - Optical Measurement Techniques and Instrumentation Laboratory lecture. Pre-requisite: Physics Lab 1 and 2 for Scientists and Engineers (Physics 2215 and 2225), or an equivalent basic Physics laboratory course. Ideally the student will also have completed the undergraduate laboratory (Physics 3719) and/or the Modern Optics Laboratory (Physics 6750).

**Learning Objectives**

After having completed this course, students will understand and be able to use advanced measuring devices such as lock-in-amplifiers, Fabry Perot interferometers, ellipsometers, heterodyne interferometers, spectrometers, Babinet-Soleil compensators, and PIN photodiodes. Optical modulation devices will be used for amplitude modulation and frequency shifting. The use of common electronic equipment such as oscilloscopes, multimeters, function generators, and amplifiers will be practiced throughout the course. The student will understand Gaussian beam properties of lasers and be able to perform calculations and measurements of beam waist, angle of divergence, and Rayleigh range and will be able to predict how lenses change these properties. The student will learn about the different types of noise through measurements and comparisons to theoretical predictions. Error analysis and least square fitting will be introduced and practiced. Laboratory reports will be written up by the students on a weekly basis to teach students proper documentation and communication. Near the end of the semester each student will learn to create a 10-minute APS (American Physical Society) style presentation relating to one of the performed experiments. The presentation will be given to the other members of the course during one of the Physics 6770 lecture times.
Mandatory Topics
- First order systems: Resistor/Capacitor (RC) low pass filter and thermopile (4)
- Second order systems: Cantilever response (4)
- Fabry Perot Interferometer (4)
- Gaussian Beam Properties (4)
- PIN photodiodes (4)
- Noise (4)
- Heterodyne Interferometer (4)
- Polarization (4)
- Ellipsometry (4)
- Manual Spectroscopy (4)
- Acton Spectrometer (4)
- Signal Transmission with a Laser (4)

Optional Topics
- Accousto Optic Modulator and Optical Ranging (4)

Canvas Course Material

Most course material on the Canvas site can be found by clicking on “Modules”. The Canvas serves several purposes:
1. Provides General course information.
2. Provides lab instructions and supplemental material.
3. Contains student scores which are accessible for each student, allowing the student to double check recorded scores.
4. Allows one-on-one communication between students and teachers.
5. Allows discussions among all students and teachers in an online format.
6. Is the venue for submission of completed lab reports.

Lab Reports:

The lab activity is performed in a group and group members share the acquired data. However, each group member is required to write individual lab reports based on these data. The lab reports will be submitted through Canvas and the deadline is typically 1 week after the completion of the lab activity.

Grading

Physics 6775 is a graded two credit hour course. Grades of A, B, C, D, and E will be assigned on the basis of your performance in the course. The course grade will be based on grades obtained in 11 equally weighted lab reports (10 points each). In addition, a bonus activity (signal transmission with a laser) will be offered, and upon successful completion the student can earn up to 5 additional points which will be added to prior lab reports in which less than 10 points were obtained. No lab report will exceed 10 points including bonus points.
Laboratory Safety:

Eating and drinking in the laboratory is not allowed. While we generally do not use severely toxic chemicals in this lab, it is always good practice to refrain from consuming food and beverages in a laboratory environment. You never know what materials have been handled in a lab prior to your use. This is for your own health and safety as well as for the protection of equipment that can be damaged by spilled fluid and such. If you need to eat or drink something, please go to the bathroom, wash your hands thoroughly, and then consume your beverage outside of the lab room in an appropriate venue.

Please follow all safety instructions provided. Closed shoes are recommended.

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)

*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.*