

Syllabus Physics 6775 – Spring 2018

Course Number: PHYS 6775

Course Title: Optical Measurement Techniques and Instrumentation Laboratory

Representative Textbook(s):

Laboratory instructions will be handed out as needed by the instructor. 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 enable the students to handle optical equipment and to apply the theoretical knowledge acquired in the PHYS 6770 lecture class. This class is for advanced students who have already completed at least a general physics lab in the past 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 spectrosopes, 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)

Optional Topics

- Acousto Optic Modulator and Optical Ranging (4)
- Signal Transmission with a Laser (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.

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 may be offered, and upon successful completion the student may get additional points on one lab report with a limit of 5 pts maximum added and not to exceed the total maximum number of pts (10 pts) for that lab. Also, there will be a yet to be determined number of mini quizzes with a relatively small number of points (maybe 5 pts total) contributing to the grade. They typically occur in conjunction with preparation for an upcoming lab and will be announced on Canvas.