PHYSICS 134

OPTICS LABORATORY

SPRING 2016

Table of Contents

Introduction & Schedule iii

Experiment 1 – Fraunhofer and Fresnel Diffraction:
Diffraction Patterns of a Circular Aperture and a Straight Edge 1-1

Experiment 2 – Grating Spectrometer:
High-Resolution, Automated Spectral Studies of Hg, Na, H, and the Sun 2-1

Experiment 3 – Scanning Fabry-Perot Interferometer:
Measurements of the Mode Structure and Zeeman Effect in a He-Ne Laser 3-1

Experiment 4 – Michelson Interferometer:
Observation of White Light Fringes, Measurement of the Wavelength of a He-Ne Laser, and Measurement of the Refractive Index of Air 4-1

Experiment 5 – Fourier Transform Spectroscopy:
Determination of the Na Doublet Splitting and of the Hg Pressure-Broadened Linewidth 5-1

Experiment 6 – Quantum Mechanics and Quantum Optics:
Existence of Single Photons and Photon Statistics 6-1

Experiment 7 – Thin lenses 7-1

Experiment 8 – Fresnel Coefficients for Reflection of Light 8-1

Introduction & Schedule

This laboratory/lecture course is designed to:

1. reinforce and extend your skills in designing an experiment to test a hypothesis, and to fine-tune your expertise in rigorously analyzing the results of your measurements to determine if the hypothesis has been disproved or supported by your experimental studies.
2. extend your knowledge of theoretical optics and introduce new experimental techniques in optics.
3. engage you in performing interesting and challenging experiments in optics, pique your interest in experimental physics, and inspire you to pursue a career in science.

The course consists of 3 laboratory experiments, one technical report project, and roughly 18 lectures with two associated problem sets. There is also a 60-minute final exam. The experiments are to be chosen from six possible experiments that are currently set up in the laboratory. The lectures will be given during the first half of the semester, at 10 AM on Monday, Wednesday, and Friday of each week. **The first lab meeting will be a working session!** It is important that you read the lab manual and indicate to your instructor by email which experiment you would like to perform first.

A schedule of lab meetings appears on page v. Three laboratory meetings are allotted for each of the experiments. The lab instructions leave a good deal of room for your own creativity, so you will need to think carefully about each experiment **before** coming to lab. References are given in the laboratory instructions to background reading material which can be found in the main laboratory, Jacobs B121. You are encouraged to browse through the books and read them in the lab, but **please do not remove these books from the lab**! If you photocopy the sections or chapters of interest, we can all share the books harmoniously.

An important lesson in working effectively in a laboratory is to arrive well-prepared. To encourage you to do this, we are requiring reading logs. That is, by noon of the day of the first lab meeting for each experiment, you must send your instructors email demonstrating that you understand the main point of the experiment. In addition, you should include any questions that have already occurred to you. At the discretion of your instructor, there may be additional reading logs required for later days in the experiment.

Laboratory notebooks are an important part of this lab course and will be primarily a diary of what you do in the laboratory; they should also include an informal summary of results, data analysis, and conclusions at the end of each week's work. At the end of each experiment, a formal summary with data plots, measured values with uncertainties, and any final insights should be integrated into a Word or LaTeX document ("summary report"). These reports are typically 7–10 pages long. The source file and a pdf version should be submitted on Sakai, and a hard copy should accompany the lab notebook for grading and feedback. These electronic "summary reports" will be archived and shared with future students who are pursuing topics that overlap with your work. Lab notebooks and summary reports of an experiment are due two days before the first lab meeting of the next experiment, so that you will have time to prepare for the next experiment. That is, the

Friday section will submit notebooks on Wednesday before noon, etc.; see the calendar on page v.

There will be a multiple choice final exam given at the end of the semester. Questions on the exam will cover the material in the lectures, problem sets, and all experiments set up in the laboratory. However, the exam will be graded so that you can obtain a score of 100 even if you choose not to answer the questions pertaining to the experiments that you have not performed.

The grades on the three summary reports, the technical report, and the combined grades in the homework, reading logs, and final exam will be equally weighted (1/5 each) to derive the final grade in the course. **As a general rule, the grade for a late notebook writeup will be reduced based on how late the work is submitted**. Exceptions will of course be made for illness, natural disasters, or similar unusual circumstances. Please be sure to apprise your instructor of (potentially) extenuating circumstances.

This course carries two units of academic credit, and hence you should be devoting an **average** of 6 hours/week (absolute maximum average of 8 hours/week) to the course. This figure includes the 3-hour lab session and 1.5 hours of lecture (averaged over the semester) each week. If you find that you must spend more time than this to complete the work to your satisfaction, please notify your instructor. We intend this course to pique your curiosity and provide an outlet for your creativity, not to beat you senseless with a heavy load of required work. If you enjoy this course as much as the instructors do, it will be a high point of your semester.

Semester Calendar - The notation "1-1" indicates the first experiment of the semester, and the first week of three weeks spent on that experiment. "3-2" means the third experiment of the semester, and the second of three weeks spent on that experiment.

	Wednesday	Thursday	Friday
LAB MEETING WEEK	**Section**	**Section**	**Section**
Tues, Jan 19 – Fri, Jan 22	1-1	1-1	1-1
Mon, Jan 25 – Fri, Jan 29	1-2	1-2	1-2
Mon, Feb 1 – Fri, Feb 5	1-3	1-3	1-3
Mon, Feb 8 – Fri, Feb 12	2-1	2-1	2-1
Mon, Feb 15 – Fri, Feb 19	2-2	2-2	2-2
Mon, Feb 22 – Fri, Feb 26	2-3	2-3	2-3
Mon, Feb 29 – Fri, Mar 4	3-1	3-1	3-1
Mon, Mar 7 – Fri, Mar 11	3-2	3-2	3-2
Mon, Mar 14 – Fri, Mar 18	******** Spring Break!! *******		
Mon, Mar 21 – Fri, Mar 25	3-3	3-3	Chavez/3-3*
Mon, Mar 28 – Fri, Apr 1	TR-1	TR-1	TR-1
Mon, Apr 4 – Fri, Apr 8	TR-2	TR-2	TR-2
Mon, Apr 11 – Fri, Apr 15	TR-3	TR-3	TR-3
Mon, Apr 18 – Fri, Apr 22	TR-4	TR-4	TR-4
Mon, Apr 25 – Fri, Apr 29		Reports due	

Summary reports and lab notebooks are due two days before the next lab meeting for the next experiment before NOON on:

Monday Tuesday Wednesday

The 60-minute final exam will be given on Friday, May 6 at 1:30 PM.

* This session should be rescheduled on an individual basis with Prof. Haskell.