OPTI 513L / Optical Testing Lab

Course Description:
Measurement of paraxial properties of optical components, refractive index, surface figure, and surface finish.

Objectives:
This class introduces students to equipment and techniques for setting up optical testing configurations and making measurements in the lab. The labs should demonstrate some fundamentals of optical metrology solutions.

Learning Outcomes:
Upon completion of this course, students will be able to:
- Measure the aberration of optical systems
- Build interferometers and acquire fringe data
- Analyze and process the interferograms
- Assess and make alignments of optical configurations on the optical table

Course Web-site:
https://sites.google.com/site/opti513l/

Prerequisite Course:
OPTI 513R (A student may take both OPTI513R and OPTI513L in the same semester.)

Grading Policy:
The grade for this course is based on your lab notebook (75%), which requires lab and lecture session attendance, and a final group presentation (25%).

The notebooks will be graded on the basis of completeness of the lab write-up. Lab notebooks will be collected during the semester and graded. Also, we will always be happy to look at your notebooks throughout the term.

The lab notebook is the most important part of the lab. You need to keep your notebook up to date, and write in it as you do the lab. You must use a bound notebook that has numbered pages that cannot come out. Your notebooks must contain everything needed to reproduce the experiment:

- Date, time, lab partner(s)
- Purpose of the experiment
- Diagrams of set-ups
- All observations and comments
- Required calculations with equations
- Answers to the questions from the handouts

The notebook must be legible and neatly done so somebody else reading your notebook could understand what you did. All markings in the lab notebook should be made in pen.

It is a good idea to cut out and tape relevant material into your notebook where appropriate. It is also useful to keep a table of contents for your notebook.

At the end of the term, each lab group must present a 30 minutes presentation covering a topic of your choice from this course. At the beginning of the presentation, the contribution of each member (e.g. experiment, analysis, slide preparation, actual presentation) should be clearly stated and introduced. The group presentation will be worth 25% of your grade. It must show your results in a complete and concise way. The main purpose of the final presentation is to show that you can communicate your ideas.

Schedule

The class meets weekly (50 minutes lecture session) to study the upcoming lab's contents and concepts and to discuss results from the previous lab. The lab work should be done in groups of three to five students per group, in three hour weekly sessions. Most labs can be done in one or two weeks, but several of the labs will be done over three weeks.

Each group must schedule their lab session with the TA, who will post the schedule, and will assist with the labs. You will usually be able to stay past the scheduled time, and you can schedule additional time in the lab. You may have access to the lab after hours by coordinating with TA.

Lab Outline

Note: Some specific lab sessions/contents might be updated/replaced/removed considering the most effective and up-to-date instruments and resources in order to maximize the educational value.

1. Fundamental Metrology Topics: Measuring Paraxial and Basic Properties (focal length, radius of curvature, index) of Lenses and Mirrors

2. Optical Alignment: Autocollimator & Alignment Telescope to Align Optical Systems

3. Qualitative Quick Tests: Knife Edge, Ronchi Test, Schlieren Test

4. Modern Metrology Systems: Commercial Fizeau Interferometer and Whitelight Interferometer

5. Basic Interferometry: Table-Top Interferometer (e.g., Mach-Zehnder or Twyman-Green) Set Up

6. Metrology Data Processing: Table-Top Interferometer (e.g., Mach-Zehnder or Twyman-Green) Phase-Shifting & Data Acquisition

7. Physical Contact Type Metrology: Profilometry and Coordinate Measuring Machine (CMM) Metrology

8. Non-Null Testing: Deflectometry for Freeform Optical Metrology

9. Aspheric Metrology: Interferometry using CGH (Computer Generated Hologram)