OPTI 502L / Fundamentals of Applied Optics Lab

Course Description:
Optical systems: Gaussian optics, aberrations, radiometry, sources, detectors, optical engineering.

Objectives
This class introduces students to equipment and techniques for setting up optical experiments and making measurements in the lab. The labs should demonstrate some fundamentals of applied optics – geometric optics and radiometry.

Course Web-site:
https://sites.google.com/site/opti502l/

Learning Outcomes:
Upon completion of this course, students will be able to:
- Handle and utilize basic optical components such as prisms and lenses
- Design and set up basic optical configurations on the optical table
- Check the aberration and align basic optical configurations on the optical table
- Control illumination settings for different optical systems
- Measure the irradiance of electromagnetic field in an optical system

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 and answering the questions. 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 week, but several of the labs will be done over two 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

1. Orientation, mechanical measurement:
    - Orientation to lab, set up groups
    - Common tools for measurements, error analysis
2. Images, prisms, and mirrors:
    - Handling cleaning, and mounting optical elements
    - Image formation
    - Properties of windows, mirrors, prisms
3. Thin lenses and alignment:
    - Techniques for measuring focal length of thin lenses
    - Angular measurement using an autocollimator
    - System alignment
4. First-order design and assembly:
    - Design and assemble a riflescope
    - Measure first-order properties with and without field lenses
    - Simulate the optics with optical analysis code
5. Lens layout and construction:
    - Disassemble a lens. Study the construction and lens spacing.
    - Measure curvatures and calculate cardinal points of the elements.
    - Use nodal slide to determine cardinal points of a lens.
6. Telephoto lens and Zoom lens:
    - Basic principle of telephoto and zoom lens
7. Illumination:
    - Investigate different types of illumination in a microscope.
    - Investigate tradeoffs between incoherent and coherent illumination.
8. Aberrations I:
    - Generate and evaluate optical aberrations
    - - defocus, chromatic aberrations, spherical aberration, astigmatism
9. Aberrations II:
    - Generate and evaluate optical aberrations
    - - coma, distortion, and field curvature.

10. Radiometry and Photometry:

Study radiometric concepts using a lens and an incoherent source.
Measure throughput and vignetting effects.
Measure properties of Lambertian source and point source.
Make photometric measurements.