

OPTI 415 - OPTICAL SPECIFICATIONS, FABRICATION AND TESTING

Course Description:

Specification of optical components including tolerancing and drawing preparation, material properties, performance metrics; conventional fabrication methods for refractive and reflective optics; optical testing including interferometric testing of surface form and finish, special techniques for aspherics, error analysis, test calibration; and testing of optical systems.

Learning Outcomes:

At the conclusion of this class, the student will be able to

- list the potential optical system specifications, based on surface, wavefront and material properties.
- describe the common surface form and wavefront errors or real non-axial optical systems in terms of more complex mathematical models such as Zernike polynomials, Chebyshev polynomials, radial basis functions and Q-polynomials.
- determine which of a variety of non-interferometric and interferometric metrology systems can verify the performance of a given part.
- understand the available glass and polymer materials for different optical systems, fabrication techniques for each material type and whether the material is suitable for a given application.
- create ISO10110 compliant optical drawings that incorporate the requirements of the optical design and define the testing protocol for verification

Grading

Homeworks 33% (approximately 8 homeworks)

Midterm 33%

Final Project 34% (Due last day of class)

Homework grades will be decreased by 10% for each day they are late.

Textbook:

Required

Schwiegerling J. Optical Specification, Fabrication and Testing. (SPIE, Bellingham, WA, 2014).

Recommended

Malacara D. Optical Shop Testing, 3rd Ed. (Wiley-Interscience, Hoboken, NJ, 2007).

Smith WJ. Modern Optical Engineering, 3rd Ed. (McGraw-Hill Professional, New York, NY, 2000).

Fischer R. Optical System Design, 2nd Ed. (McGraw-Hill Education; New York, NY, 2008).

Outline

1. PROPERTIES OF OPTICAL SYSTEMS

- Review of the FIRST ORDER PROPERTIES
- Specification of these properties with ISO10110 Drawings
- Measurement of the FIRST ORDER PROPERTIES
- The effect of DIFFRACTION AND ABERRATIONS on the optical system.
- Description of WAVEFRONTS AND SURFACES that violate axial symmetry.
- OPTICAL QUALITY METRICS
- ASPHERIC SURFACES and their specification with ISO10110 Drawings

2. NON-INTERFEROMETRIC TESTING

- Techniques for assessing the surface shape and wavefronts without interference
- Contact techniques

- Foucault, Wire and Ronchi Tests
- Hartmann and Shack-Hartmann techniques
- Deflectometry

3. BASIC INTERFEROMETRY AND OPTICAL TESTING

- REVIEW OF TWO BEAM INTERFERENCE
- NEWTON'S RINGS and extension to FIZEAU INTERFEROMETERS
- TWYMAN-GREEN INTERFEROMETER
- MACH-ZEHNDER INTERFEROMETER
- LATERAL SHEARING INTERFEROMETERS
- INTERFEROGRAM analysis and PHASE-SHIFTING INTERFEROMETRY
- Specification of surface and wavefront characteristics with ISO10110 Drawings.

4. FABRICATION OF OPTICAL SURFACES

- Glass and plastic optical materials
- Traditional grinding and polishing techniques
- Surface finishing techniques
- Diamond turning techniques
- Glass and plastic molding
- Specification of material properties with ISO10110 Drawings.