Introduction to Aberrations
OPTI 518

Prof. Jose Sasian

Syllabus

Syllabus OPTI 518

Instructor:

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Course goals:

- To acquire a strong foundation in imaging aberrations, to learn how to calculate aberration coefficients, to understand and calculate the aberrations of optical systems, understand how light propagates in an optical system.
- An emphasis in applications for optical engineering.
- An emphasis on symmetry.

Schedule:

- MW, 1:00-2:15 AM, OPTI 307
- => 95% A
- => 85% B
- => 80% C

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References:

- Class notes
- “Introduction to aberrations in optical imaging systems,” J Sasian, Cambridge University Press
- Roland Shack’s class notes (in the class web site)
- http://fp.optics.arizona.edu/sasian/opti518/

Office hours

- By email appointment

Learning Outcomes

- Explain ideal imaging
- Explain axial symmetry in lens systems
- Explain plane symmetry in lens systems
- Explain geometrical and physical image formation
- Explain the point spread function
- Explain the aberration function
- Explain the types of aberrations
- Calculate aberration coefficients
- Explain wave and ray fans
- Explain spot diagrams
- Explain caustics
- Explain aberration correction and balancing
- Explain pupil aberrations
- Use structural aberration coefficients
- Explain the irradiance function
- Describe aberrations of confocal paraboloids
- Explain an aplanatic lens system
- Explain an anastigmatic lens system
- Explain the sine condition
- Explain the Coddington equations
- Explain the Rayleigh-Strehl ratio

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Preliminaries

- Imaging
- Geometry and Coordinate systems
- Optical path length, optical path difference
- Axially symmetric systems and other types of system symmetry
- Geometrical wavefront propagation and aberration theory goals
- Images and their relationship to the geometrical wavefront
- Review of pupils and field and aperture vectors

Wave and ray aberrations

- Wave aberration function scalar and vector representation
- Classification of wavefront aberrations
- Fourth order and sixth order aberrations
- Aberration coefficients
- Wavefans, meridional and sagittal
- Chromatic aberrations

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Wave and ray aberrations (cont.)

- Transverse ray aberrations
- Relation to wave aberrations
- Ray fans
- Spot diagrams and grid choice
- Caustics
- Change of reference sphere
- Interferometric representation of aberrations
- Point Spread function
- Aberrated spread function
- Rayleigh-Strehl ratio
- Aberration balancing
- Focus, tilt, spherical aberration, coma, astigmatism

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Aberration Coefficients

- Seidel sums
- Petzval field curvature
- Spherical aberration
- Field dependent aberrations
- Stop shifting
- Special surfaces
- Structural aberration coefficients

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Simple systems

- Thin lens
- Single mirrors; aspheric; corrector plates
- Thin lenses in contact; achromatic doublet
- Compound lens systems
- Compound mirror systems

Other topics (time permitting)

- Pupil Aberrations
- Irradiance function
- Aberration tolerances
- Zernike polynomials
- Non-symmetrical systems
- Polarization aberrations

Academic Integrity

- ***Academic Integrity***
  According to the Arizona Code of Academic Integrity (http://dos.web.arizona.edu/uapolicies/cai2.html), "Integrity is expected of every student in all academic work. The guiding principle of academic integrity is that a student's submitted work must be the student's own." Unless otherwise noted by the instructor, work for all assignments in this course must be conducted independently by each student. CO-AUTHORED WORK OF ANY KIND IS UNACCEPTABLE. Misappropriation of exams before or after they are given will be considered academics misconduct.

  Misconduct of any kind will be prosecuted and may result in any or all of the following:
  ** Reduction of grade*
  ** Failing grade*
  ** Referral to the Dean of Students for consideration of additional penalty, i.e. notation on a student's transcript re. academic integrity violation, etc.*

  Students with a Learning Disability
  If a student is registered with the Disability Resource Center, he/she must submit appropriate documentation to the instructor if he/she is requesting reasonable accommodations. (http://drc.arizona.edu/instructor/syllabus-statement.shtml).