

# Advanced Lens Design

## OPTI 696A

Prof. Jose Sasian

## Syllabus



# Syllabus OPTI 696A

## Instructor:

- Jose Sasian
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- OSC Room 305
- 520 621 3733

## Course goals:

- To learn advanced lens design methods.

## Schedule:

- T-Th 2 PM to 3:15 PM

## Grade

- Based on HW and on watching all lectures.
- Must watch all lectures.



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## References:

- Class notes in the course Web site
- Introduction to aberrations in optical imaging systems, J Sasian, Cambridge University Press
- Introduction to Lens Design, J Sasian, Cambridge University Press
- <http://fp.optics.arizona.edu/sasian/opti696A/>

## Office hours

- By email appointment



# Learning Outcomes

- Explain optical specifications and the compliance matrix
- Explain and design apochromatic objectives
- Explain lens athermalization
- Produce ghost image analysis
- Explain and produce uniform illumination using LEDs and Gaussian beams
- Explain and apply the method of confocal mirror design
- Explain and design lenses without ghost images
- Produce stray light analysis
- Explain aberrations in non-axially symmetric systems
- Explain the irradiance function
- Explain and design zoom lenses
- Desensitize a lens for tolerances
- Explain optical drawings



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## Topics

- Design of apochromats and super-achromats
- Lens athermalization; opto-thermal coefficient
- Optical drawings; lens specifications
- Ghost image analysis
- Radiometry of a lens system
- Gaussian to flat-top lenses
- Uniform illumination LED lenses
- Aberrations of non-axially symmetric systems
- Method of confocal mirror design



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## Topics

- Designing with off-the-shelf lenses
- Miniature lenses: mobile phone lenses, microscope objectives, endoscope lenses
- Tolerancing and lens de-sensitization
- Zoom lenses
- Mirror systems
- Catadioptric systems
- Lenses for micro-lithography
- Polarization aberrations
- Guest lecturers



## Books about design

Bentley, J., Olson, C. *Lens Design* (Bellingham, WA: SPIE Press, 2012).

Clark, A. D. "Zoom lenses," in *Monographs in Applied Optics*, Vol. 7 (London: J. H. Dallmeyer, Ltd., 1873).

Conrady, A. E. *Applied Optics and Optical Design*, Part I (New York: Dover, 1957).

Conrady, A. E. *Applied Optics and Optical Design*, Part II (New York: Dover, 1957).

Cox, A. *A System of Optical Design* (New York: Focal Press, 1964).

Dilworth, D. *Lens Design* (Bristol, UK: IOP Publishing, 2018).

Fischer, R., Tadic-Galeb, B., Yoder, P. *Optical System Design* (New York: McGraw-Hill, 2008).

Geary, J. M. *Introduction to Lens Design—With Practical Zemax Examples* (Richmond, VA: Willmann-Bell, 2002).

Gross, H. *Handbook of Optical Systems*, Vols. I–IV (Weinheim: Wiley-VCH, 2005).

Johnson, B. K. *Optical Design and Lens Computation* (London: The Hatton Press Ltd, 1948).

Kidger, M. *Fundamental Optical Design* (Bellingham, WA: SPIE Press, 2002).

Kidger, M. *Intermediate Optical Design* (Bellingham, WA: SPIE Press, 2004).

Kingslake, R. *A History of the Photographic Lens* (San Diego, CA: Academic Press, 1989).

Kingslake, R. *Optical System Design* (San Diego, CA: Academic Press, 1984).

Kingslake, R., Johnson, R.B. *Lens Design Fundamentals* (Amsterdam: Elsevier Inc., 2010).

Laikin, M. *Lens Design* (New York: Dekker, 2001).

Lummer, O. *Contributions to Photographic Optics* (London: MacMillan and Co., Limited, 1900).

Malacara, D., Malacara, Z. *Handbook of Lens Design* (San Diego, CA: Academic Press, 2013).

Mouroulis, P., Macdonald, J. *Geometrical Optics and Optical Design* (New York: Oxford Press, 1997).

Nakajima, H. *Optical Design Using Excel* (New York: Wiley, 2015).

Nussbaum, A. *Optical System Design* (Upper Saddle River, NJ: Prentice Hall, 1998).

O'Shea, D. *Elements of Modern Optical Design* (New York: Wiley, 1985).

O'Shea, D., Bentley, J. *Designing Optics Using CODEV* (Bellingham WA: SPIE Press, 1997).

Ray, S. F. *Applied Photographic Optics*, 2nd ed. (New York: Focal Press, 1997).

Riedl, M. *Optical Design, Fundamentals for Infrared Systems* (Bellingham, WA: SPIE Press, 2009).

Shannon, R. R. *The Art and Science of Optical Design* (Cambridge, MA: Cambridge University Press, 1997).

Slyusarev, G. G. *Aberration and Optical Design Theory* (Boca Raton, FL: CRC Press, 1984).

Smith, G. H. *Practical Computer-Aided Lens Design* (Richmond, VA: Willmann-Bell, 1998).

Smith, W. J. *Modern Lens Design* (Bellingham, WA: SPIE Press, 2008).

Sun, H. *Lens Design – A Practical Guide* (New York: CRC Press, 2017).

Taylor, H. D. *A System of Applied Optics* (London: Macmillan, 1906).

Velzel, C. *A Course in Lens Design* (Berlin: Springer, 2014).

von Rohr, M. *The Formation of Images in Optical Instruments* (London: H. M. Stationary Office, 1920).

Yabe, A. *Optimization in Lens Design* (Bellingham, WA: SPIE Press, 2018).



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*Misconduct of any kind will be prosecuted and may result in any or all of the following:*

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*\* 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.*

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