Advanced Lens Design
OPTI 696A

Prof. Jose Sasian

Syllabus

THE UNIVERSITY OF ARIZONA
James C. Wyant
College of Optical Sciences

Syllabus OPTI 696A

Instructor:

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- OSC Room 305
- 520 621 3733

Course goals:

- To learn advanced lens design methods.

Schedule:

- TTh TBD

Grade

- Based on HW

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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 (Weiheim: 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,
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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At the University of Arizona, we strive to make learning experiences as accessible as possible. If you anticipate or experience barriers based on disability or pregnancy, please contact the Disability Resource Center (520-621-3268, https://drc.arizona.edu/) to establish reasonable accommodations.

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  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).

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KEEPING OUR CLASS HEALTHY

3 SIMPLE STEPS TO KEEP EACH OTHER SAFE

BEAR DOWN and...

1 MASK UP

2 VAX UP

3 GET TESTED

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1. Mask up

1 MASK UP

FACE COVERINGS ARE REQUIRED

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1. Mask Up continued 1

1 MASK UP

FACE COVERINGS ARE STRONGLY RECOMMENDED

EVERYWHERE YOU SEE THIS SIGN, INCLUDING WHEN YOU ENTER THIS BUILDING

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1. Mask up continued 2

1 MASK UP

Make sure your mask covers your nose and mouth

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1. Mask up continued 3

1 MASK UP

If you forget your mask, please just ask and we'll aim to find one for you.

And … pick up FREE cloth masks at the Bookstore!

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1. Mask up continued 4

1 MASK UP

Failure to comply will result in students being asked to leave the classroom and / or other disciplinary actions, including possibly being dropped from this class.

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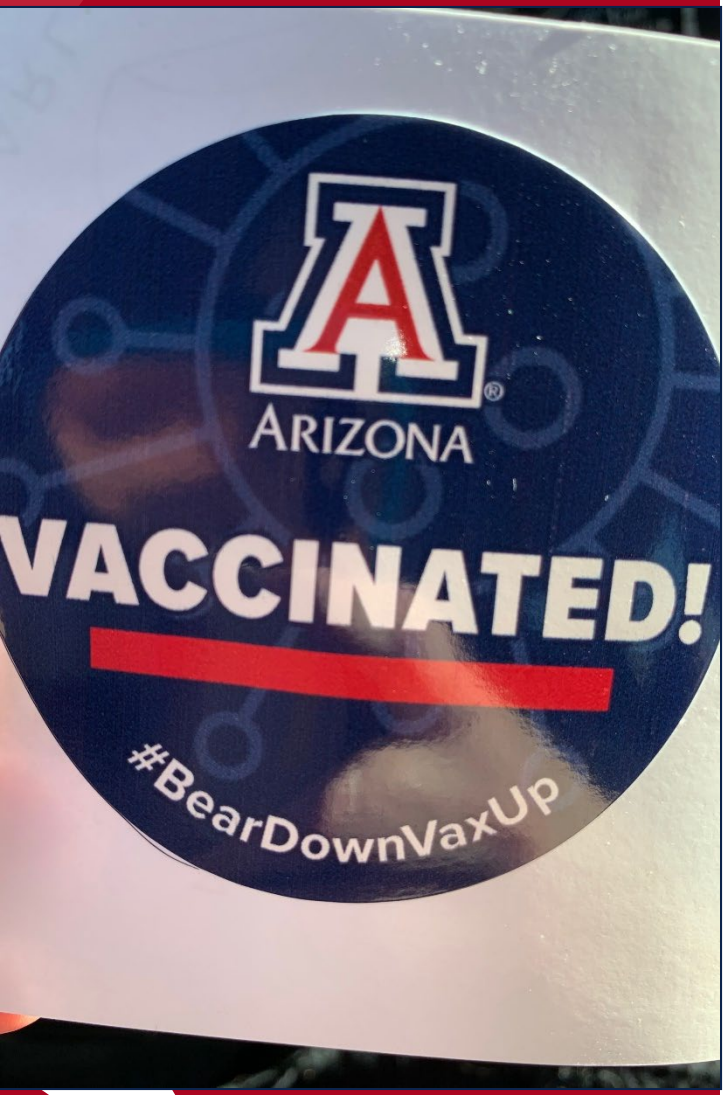
2. Vax Up



2 VAX UP

- Upload your vaccine data and enter a chance to win prizes!
  This helps us know how many people on our campus are already protected.
- Get vaccinated at **Campus Health** (or any other location).
- See more at health.arizona.edu.

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3. Get Tested

3 GET TESTED

- Testing regularly – **ideally once a week** – helps minimize your risk of unknowingly infecting others, even if you've been vaccinated.
- It's free, fast and easy – find locations and hours at COVID19.arizona.edu

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LET'S KEEP EVERY WILDCAT SAFE AND HEALTHY!

1 MASK UP | **2** VAX UP | **3** GET TESTED

AND BEAR DOWN!

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