Introduction to Lens Design
OPTI 517

Syllabus

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Syllabus OPTI 517

Instructor:

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Course Goal

- To learn the skill of lens design. For this there will be a significant amount of practical
- lens design homework.

Schedule

- M-W-F 11:00 AM to 12:15 PM

Office hours

- By email appointment

Homework

- There are nine homework sets. Each homework set must be organized, legible, and neatly presented.
- There will be one week of grace period to turn in the HW's. After that there will be a 20%, HW grade, penalty for each week that the HW is late starting from the due date.
- All materials, including the class summary must be turned in by the last day of classes, sharp at 5:00 PM. No exceptions here. The grace period will not apply for any HW for those asking for an incomplete.

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- **Exams**
  There will be only a midterm exam.
- **Final grade**
  Will be based on the sum of all the homework points, the midterm exam, and the course summary
  Homework 55%
  Midterm exam 45% (around October/November)
- **Software**
  Codev, OpticStudio, Oslo, Synopsys, Optalix
- Must get on board asap using the software

Learning Outcomes

- Explain imaging
- Explain axial symmetry in lens systems
- Explain F-number, field of view, and the aperture stop
- Use lens design software
- Explain aberrations in lens systems
- Explain aspheric surfaces
- Explain real ray tracing
- Explain ray tracing pitfalls
- Explain correcting for spherical aberration
- Explain chromatic aberration and glass selection
- Explain field curves
- Explain the Petzval sum
- Explain the concept of artificially flattening the field
- Explain how the Wollaston landscape lens works
- Explain and design a Cooke triplet
- Explain modeling a diffractive optical element
- Explain and design an Offner null corrector
- Explain and design a double Gauss lens
- Explain and apply lens tolerancing
- Explain Monte-Carlo trials
- Explain and apply lens optimization
- Explain MTF curves

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OPTI517 Lectures

- Imaging
- Review of first-order optics
- Aberration theory I
- Aberration theory II
- Higher order aberrations
- Control of spherical aberration
- Ray tracing
- Chromatic aberrations I
- Chromatic aberrations II
- Control of coma
- Control of astigmatism, field curvature and distortion
- The Brownie camera

OPTI517 Lectures

- Image evaluation
- Periscope lens
- The Petzval portrait lens
- Diffractive lenses
- Lens optimization
- Cooke triplet
- Double Gauss
- Pupil effects
- Tolerancing I
- Tolerancing II
- A periscope lens design
- Lens manufacturing

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OPTI517 Demos

- How a lens design program works
- Synopsys
- Code v
- Zemax- optimization
- Lens for laser diode collimating
- Critical air-space doublet
- Dall and Offner null correctors
- Monochromatic quartet achromatization
- Shupman medial telescope
- Maksutov, Houghton, and Schmidt cameras

OPTI517 Demos

- Landscape lens, Chevalier, periscope lens
- Petzval portrait lens and field flattener
- Phase, hologram, and Sweatt models
- Rapid rectilinear, meniscus and landscape lens
- Protar and optimization hints
- New-achromat and Schroeder lens
- Cooke triplet and as telecentric lens
- Double Gauss and derivatives
- Tessar lens
- Tolerancing
- A periscope design
- Lenses for microlitography

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The field and art of lens design

Developing a skill:

- the theory
- the program
- the experience

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References

1. R. R. Shannon, ‘The art and Science of Optical Design,
2. ’ Cambridge University Press 1997.
3. Kingslake-Johnson, ‘Lens Design Fundamentals,’ Elsevier.
4. M. J. Kidger, “Fundamental Optical Design,” SPIE Press, 2002.
5. M. J. Kidger, “Intermediate Optical Design,” SPIE Press, 2002.

Other references

1. Welford, Aberrations of optical systems
2. Laikin, Lens Design
3. Smith, Modern Lens Design
4. Malacara and Malacara, Handbook of lens design
5. Korsch, Reflective optics
6. Kingslake, Optical system design
7. Kingslake, History of the photographic lens
8. Cox, A system of optical design
9. Slyusarev, Aberration and optical design theory
10. MIL-HDBK 141, Optical design
11. SPIE, Critical Review 41, Lens Design
12. International Lens Design Conference Proceedings
13. Schott: Optical Glass Catalogue

Links to books in the UA Library

ART+SCIENCE OF OPTICAL DESIGN:
http://ezproxy.library.arizona.edu/login?url=https://doi.org/10.1017/CBO9780511816529
INTRODUCTION TO ABERRATIONS IN OPTIC...:
http://ezproxy.library.arizona.edu/login?url=https://doi.org/10.1017/CBO9780511795183
INTRODUCTION TO LENS DESIGN:
http://ezproxy.library.arizona.edu/login?url=https://doi.org/10.1017/9781108625388
LENS DESIGN FUNDAMENTALS:
http://ezproxy.library.arizona.edu/login?url=https://www.sciencedirect.com/book/9780123743015/lens-design-fundamentals

Accessibility and Accommodations

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.

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).

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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

IN THIS CLASSROOM AND EVERYWHERE YOU SEE THIS SIGN

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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

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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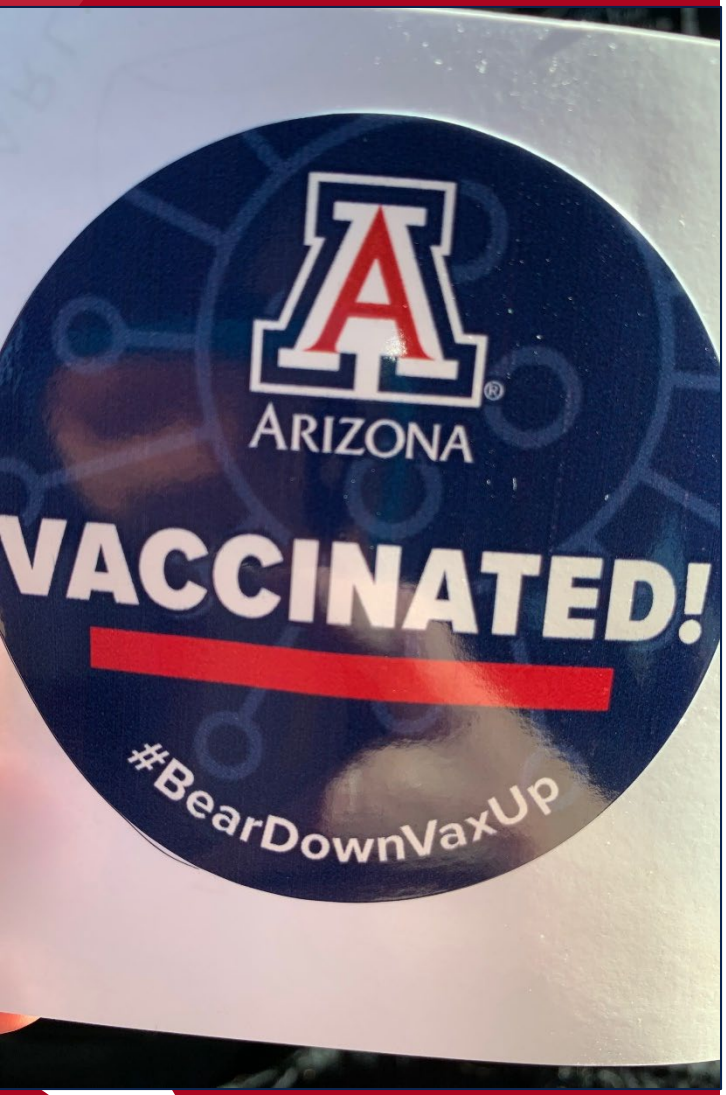
2. Vax Up



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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