

# Introduction to Lens Design

## OPTI 517

### Syllabus

Prof. Jose Sasian



# Syllabus OPTI 517

## Instructor:

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- 520 621 3733

## 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
- Synopsis
- 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 microlithography



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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**

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**2 VAX UP**

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**3 GET TESTED**

# 1. Mask up

## 1 MASK UP

FACE COVERINGS  
ARE REQUIRED

IN THIS CLASSROOM  
AND EVERYWHERE YOU  
SEE THIS SIGN



**MASKS  
REQUIRED IN  
THIS SPACE**



<https://covid19.arizona.edu/>

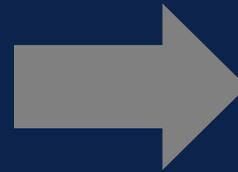


# 1. Mask Up continued 1

## 1 MASK UP

FACE COVERINGS ARE  
STRONGLY RECOMMENDED

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



# 1. Mask up continued 2

## **1** MASK UP

Make sure your mask covers your nose and mouth

# 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!

# 1. Mask up continued 4

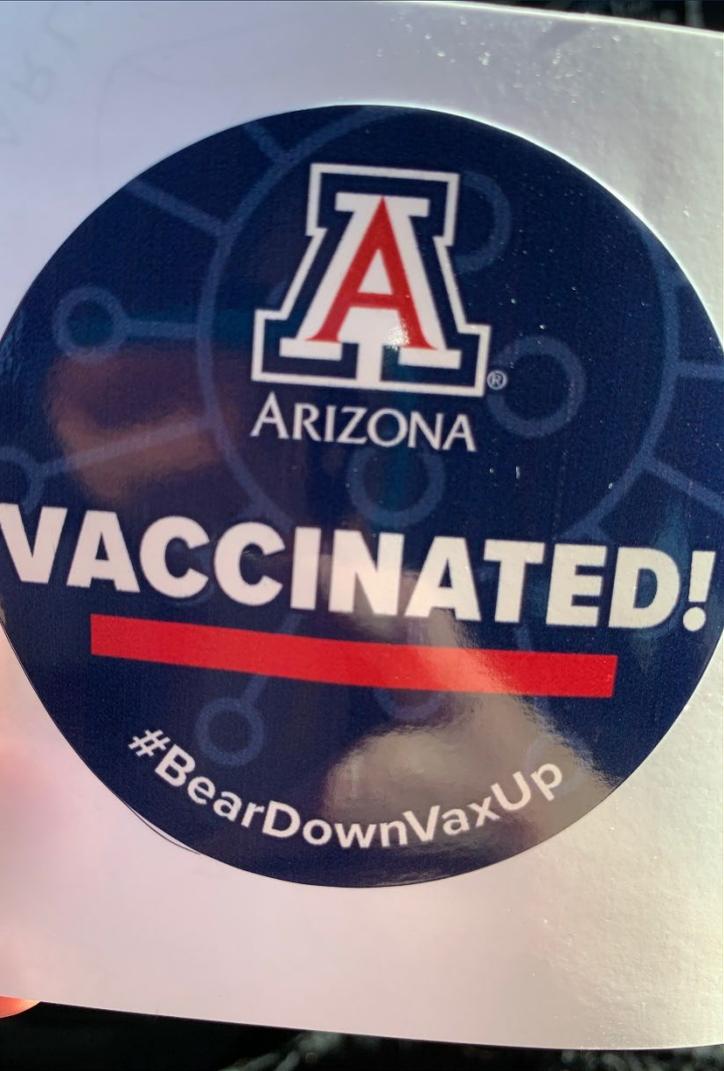
## **1 MASK UP**

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.



## 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](http://health.arizona.edu).

# 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](https://COVID19.arizona.edu)



**LET'S KEEP EVERY WILDCAT  
SAFE AND HEALTHY!**

**1 MASK  
UP**

**2 VAX  
UP**

**3 GET  
TESTED**

**AND BEAR DOWN!**



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