# SYLLABUS

## OPTI 535 Visual Optics

## Location and Times: Tuesday/Thursday 9:30-10:45 am in Meinel 305

### Description of Course

This course examines the optical properties of the human eye and applies the techniques used to assess the performance of conventional optical systems to the eye. Furthermore, the operating principals behind various ophthalmic diagnostic devices including wavefront aberrometers and corneal topographers are investigated. Surgical techniques such as LASIK and cataract surgery are explored.

### Course Prerequisites or Co-requisites

Some experience with geometrical optics, interference and diffraction is useful for the class.

### Instructor and Contact Information

Jim Schwiegerling
Meinel 725
jschwieg@u.arizona.edu
(520) 621-8688
No set office hours, but I am happy to meet with students. Contact the instructor to arrange for 1:1 meetings.

TA: None

Course home page: https://wp.optics.arizona.edu/visualopticslab/courses/opti-435535-visual-optics/

D2L information: TBD

### Course Format and Teaching Methods

Lecture only

### Course Objectives

The objective of this course is to familiarize the student with the optical properties of the human eye and the nomenclature used to describe its limitations and capabilities. The second objective of the course is to provide an understanding of the optical systems used to measure and image various components of the eye. Another objective of the course is to illustrate surgical techniques for correcting or enhancing the performance of the eye. A final objective of this class is to introduce the student to reading and dissecting patents.

### Expected Learning Outcomes

At the conclusion of this class, the student will be able to

- describe the geometrical optical properties of the eye, as well as its deficiencies such as refractive error, astigmatism and higher order aberrations.
- understand how ocular performance tests such as visual acuity and contrast sensitivity relate to optical engineering performance metrics such as resolution limit and the Modulation Transfer Function.

- provide the basic layouts for various diagnostic devices such as ocular wavefront sensors, corneal topographers, retina imaging systems and optical coherence tomographers.
- understand the mechanism of action behind surgical techniques such as LASIK and cataract surgery to correct or enhance the performance of the eye.
- review a technical patent and extract information regarding the claims and embodiments of the covered technology.

## Course Communications

Online communication will be using the official UA e-mail address through D2L

## Required Texts or Readings

There are no required materials for this class, but it is strongly recommended that the student get access to J. Schwiegerling, Field Guide to Visual and Ophthalmic Optics (SPIE Press, Washington, 2004). The cost of this book is about $42.00.

## Required or Special Materials

Access to raytracing software such as Zemax or Code V (site licensed to the College) and Matlab (site licensed to the University) or equivalent for homework assignments.

## Assignments and Examinations: Schedule/Due Dates

There are approximately 5-7 homework assignments and one midterm for the class. Late homework assignments lose 10% per day late. Dates for the assignments and test are TBD.

## Final Project

The final project for this class is to identify an ophthalmic patent and provide a review of the technology. The review will be in the form of a short summary (~4 pages) and an in-class oral presentation (5-10 minutes).

## Grading Scale and Policies

The grading scale is curved and final grades will be dependent upon the performance all of the undergraduate students enrolled in the class.

| Assessment Categories | Percentage of final grade |
|---|---|
| Midterm Exam (Date: TBD) | 35% |
| Homework assignments | 30% |
| Final Project (in-class presentation) | 35% |
| Total | 100% |

## If the course is a 400/500:

OPTI 535 is co-convened with an undergraduate version of the course. The undergraduates will have reduced homework assignments.

## Incomplete (I) or Withdrawal (W):

Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete and http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal respectively.

## Dispute of Grade Policy

Students should provide a justified description of their disputed grades within one week of its return.

## Scheduled Topics/Activities

SECTION 1

What is vision? Anatomy of the eye. Dissection. Average and range of sizes, shapes and indices of ocular components. Overview of optical modeling. Definition of visual acuity.

SECTION 2

Schematic eye models. Gullstrand-LeGrand and Helmholtz models. First-order properties. Locations of cardinal points. Definitions of near point, far point, myopia and hyperopia. Aspheric eye models. Stiles-Crawford, photopic response, diffraction. Location of eye axes. Purkinje Images

SECTION 3

Optometers, Autorefractors image analysis, retinoscopic scanning and Scheiner disk types. Fogging.

SECTION 4

Retinoscopy, sphero-cylindrical lenses, astigmatic decomposition.

SECTION 5

Spectacle lens correction, Tscherning ellipse, lensmeters, accommodation, presbyopia, near addition, progressive lenses. Contact lenses.

SECTION 6

Spherical, Chromatic, Astigmatism (axial and oblique). Techniques for measuring aberrations. Nominal values. Derivation of these quantities from raytrace data.

SECTION 7

Visual performance – Theoretical resolution. Vernier acuity, grating acuity, Snellen acuity. Vision charts. Specification of visual acuity. Contrast sensitivity. Fourier theory – PSF, MTF, modulation threshold. Campbell and Green experiments. Van Nes and Bouman experiments. Changes in contrast sensitivity. Square-wave response.

SECTION 8

Ocular wavefront sensing, Shack-Hartmann, Talbot-Moire, raytracing, performance metrics.

SECTION 9

Zernike polynomials

SECTION 10

Corneal Refractive Correction: RK/AK, PRK, ALK/LASIK, orthokeratology.

SECTION 11

Corneal topography, Placido rings, stereo-photogrammetry and scanning slit devices, Scheimpflug. (Scheimpflug Imaging Notes)  Height, slope and curvature representations of the cornea. Derivation of relationships. Keratometric index of refraction. (Differential Geometry Notes)

SECTION 12

Scatter. Intraocular lenses. Power calculations. Multifocal contact and intraocular lenses. Aphakia and pseudophakia. Defocus Transfer Function. Multifocal lenses.

SECTION 13

Measurement and imaging the retina. Direct and indirect ophthalmoscopy, fundus camera. Confocal scanning laser ophthalmoscope. Optical coherence tomography. Applications: glaucoma screening, nerve fiber layer measurement.

SECTION 14

Radiometry and Photometry. MPE.

SECTION 15

Color matching. Additive and subtractive color mixing. Color vision – Trichromatic vs. opponent-process theories. Spectral response of cone pigments. Color blindness.

Patent Class 1 - Elements of a patent.  Patent searching

Patent Class 2 - Specific Example of an ophthalmic patents.

## Classroom Behavior Policy

### Recommended language:

To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.).

### Additional recommendations depending on instructor preferences:

Students are asked to refrain from disruptive conversations with people sitting around them during lecture. Students observed engaging in disruptive activity will be asked to cease this behavior. Those who continue to disrupt the class will be asked to leave lecture or discussion and may be reported to the Dean of Students.

### Alternate language for those who want to restrict computers and laptops to an area of the classroom:

Some learning styles are best served by using personal electronics, such as laptops and iPads. These devices can be distracting to other learners. Therefore, students who prefer to use electronic devices for note-taking during lecture should use one side of the classroom.

### Alternate recommended language for those who do not wish to permit laptops in the classroom:

The use of personal electronics such as laptops, iPads, and other such mobile devices is distracting to the other students and the instructor. Their use can degrade the learning environment. Therefore, students are not permitted to use these devices during the class period.

## Notification of Objectionable Materials

Recommended language, if applicable: This course will contain material of a mature nature, which may include explicit language, depictions of nudity, sexual situations, and/or violence. The instructor will provide advance notice when such materials will be used. Students are not automatically excused from

interacting with such materials, but they are encouraged to speak with the instructor to voice concerns and to provide feedback.

## Additional Resources for Students

UA Academic policies and procedures are available at http://catalog.arizona.edu/policies

**Campus Health**
http://www.health.arizona.edu/
Campus Health provides quality medical and mental health care services through virtual and in-person care.
Phone: 520-621-9202

**Counseling and Psych Services (CAPS)**
https://health.arizona.edu/counseling-psych-services
CAPS provides mental health care, including short-term counseling services.
Phone: 520-621-3334

**The Dean of Students Office's Student Assistance Program**
http://deanofstudents.arizona.edu/student-assistance/students/student-assistance
Student Assistance helps students manage crises, life traumas, and other barriers that impede success. The staff addresses the needs of students who experience issues related to social adjustment, academic challenges, psychological health, physical health, victimization, and relationship issues, through a variety of interventions, referrals, and follow up services.
Email: DOS-deanofstudents@email.arizona.edu
Phone: 520-621-7057

**Survivor Advocacy Program**
https://survivoradvocacy.arizona.edu/
The Survivor Advocacy Program provides confidential support and advocacy services to student survivors of sexual and gender-based violence. The Program can also advise students about relevant non-UA resources available within the local community for support.
Email: survivoradvocacy@email.arizona.edu
Phone: 520-621-5767

## Confidentiality of Student Records

http://www.registrar.arizona.edu/personal-information/family-educational-rights-and-privacy-act-1974-ferpa?topic=ferpa

## University-wide Policies link

Links to the following UA policies are provided here, https://academicaffairs.arizona.edu/syllabus-policies:

- Absence and Class Participation Policies
- Threatening Behavior Policy
- Accessibility and Accommodations Policy
- Code of Academic Integrity
- Nondiscrimination and Anti-Harassment Policy
- Subject to Change Statement