SYLLABUS

ECE / OPTI 202R Geometrical and Instrumentational Optics II

Spring 2024
T/Th: 11:00 – 12:15 AM
Meinel 410

Description of Course

This course will provide the student with a fundamental understanding of optical system design and instrumentation. The course builds upon the foundations of geometrical optics that were presented in OPTI-201R to discuss a variety of elementary optical systems. Other topics include chromatic effects, camera systems and illumination optics. A special emphasis is placed on the practical aspects of the design of optical systems.

Course Prerequisites or Co-requisites

OPTI 201R

Instructor and Contact Information

Prof. Travis W. Sawyer
Bioscience Research Laboratory 324
tsawyer9226@arizona.edu
Web information: The class information will be available through D2L

TA: Shuyuan Guan (jade1101@arizona.edu)

Course Format and Teaching Methods

Lecture only.

Course Objectives and Expected Learning Outcomes

Course objectives:

1. Provide students with a basic background in geometrical optics.
2. Apply first-order optics to understand and describe optical systems.
3. Provide students with a comprehensive understanding of optical system characteristics, and cover common optical systems.
4. Explore some topics in quantum information science.

Expected Learning Outcomes:

1. Specify the requirements of an optical system for your application including magnification, object-to-image distance, and focal length.
2. Diagram ray paths and do simple ray tracing.
3. Describe the performance limits imposed on optical systems by diffraction and the human eye.
4. Predict the imaging characteristics of multi-component systems.
5. Determine the required element diameters.
6. Apply the layout principles to a variety of optical instruments including telescopes, microscopes, magnifiers, field and relay lenses, zoom lenses, and afocal systems.
7. Adapt a known configuration to suit your application.
8. Understand the process of the design and layout of an optical system.

Absence and Class Participation Policy

The UA's policy concerning Class Attendance, Participation, and Administrative Drops is available at: http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop

The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable, http://policy.arizona.edu/human-resources/religious-accommodation-policy.

Absences pre-approved by the UA Dean of Students (or Dean Designee) will be honored. See: https://deanofstudents.arizona.edu/absences

Participating in the course and attending lectures and other course events are vital to the learning process. As such, attendance is required at all lectures and discussion section meetings. Students who miss class due to illness or emergency are required to bring documentation from their health-care provider or other relevant, professional third parties. Failure to submit third-party documentation will result in unexcused absences.

It is expected that students will regularly attend class and be on time for class. If attendance drops to an unacceptable level, the instructor may implement live quizzes that will count as part of the homework grade. Any such quizzes will be given at the start of class and may not be made up, and will constitute up to 1/3 of the homework grade.

In Keeping with University policies: All holidays or special events observed by organized religions will be honored for those students who show affiliation with that particular religion. - Absences preapproved by the UA Dean of Students (or Dean's designee) will be honored. Since there is no grade for attendance for this course, these policies would apply primarily to scheduled exams. The instructor must be notified at least two weeks prior to any such absence so that appropriate accommodations can be made.

Required Texts or Readings

Field Guide to Geometrical Optics J. E. Greivenkamp 081945294-7

Note that this book is available as an e-book through the UA library as well as an app for Android (search "SPIE"). Class notes will be made available through the webpage. Alternative reading sources will be referred to throughout the class and made available in the reading room and Science Library.

Required or Special Materials

Students should have access to python and "Jupyter notebooks" and the capability to perform numerical calculations. Recommended to install anaconda: https://www.anaconda.com/

Assignments and Examinations: Schedule/Due Dates.

Homework: Homework will be assigned regularly throughout the semester with a total of 8 (plus an initial assignment), and it will be due at least one week later, usually 10 to 14 days. The purpose of the homework is for you to practice the techniques discussed in class or to reinforce this material. Completion of the homework is important to fully master this material. Collaboration and discussion of the homework is encouraged.

Homework will consist primarily of hand-worked problem sets, along with several programming questions to provide students an opportunity to build up their skillset in programming.

Homework will be turned in to D2L by 11:59 PM on the due date. Anything turned in after that time is considered late. Only electronic submissions are allowed. Approval for late homework must be obtained in advance from the instructor. Last-minute extensions will not be granted.

Project: You will complete a project in the second half of the semester focused on applying concepts in the course to real-world research to industry activities. This includes doing self-directed research on a topic of interest, interviewing/shadowing a professional in the field and writing a summary of what you learned. More details will be provided

Late Homework Policy:

- Homework that is turned in after 11:59 PM on the due date is considered late.
- Late HW will receive a 10% penalty for every 24 hours it is late. Solutions will be posted 10 days after the homework is due.
- When issues arise, please contact the instructor as soon as possible so that appropriate accommodations can be made, at least 24 hours before the homework deadline.
- Please do not email me the night homework is due with questions.

Homework due dates will be posted on D2L. Midterm 1 is scheduled for Thursday February 29 and Midterm 2 is scheduled for Thursday April 4. There will be a review session prior to each midterm.

Final Examination

The date and time of the final exam or project, along with links to the Final Exam Regulations, https://www.registrar.arizona.edu/courses/final-examination-regulations-and-information, and Final Exam Schedule, http://www.registrar.arizona.edu/schedules/finals.htm

Grading Scale and Policies

The final grade will be based on homework, two midterm exams, and a final exam.

Homework	25%
Midterm exam	20%
Midterm exam	20%
Project	10%
Final exam	25%
Total	100%

Each homework will constitute 12% of the total homework grade, except for "homework 0" which will be 4% of the total homework grade (12*8+4 = 100).

The grade will be determined according to the cumulative percentage earned such that 90-100% = A, 80-89% = B, 70-79% = C, 60-69% = D, below 60% = E. A curve may be applied at the end of the semester depending on the distribution on final grades, but this is not a guarantee. The final distribution of grades should reflect the following assessment:

A: Excellent – has demonstrated a more than acceptable understanding of the material; exceptional performance; greatly exceeds expectations

B: Good – has demonstrated an acceptable understanding of the material; good performance; meets or exceeds expectations

C: Average – has demonstrated a barely acceptable understanding of the material; adequate performance; meets minimum expectations

D: Poor – has not demonstrated an acceptable understanding of the material; inadequate performance; does not meet expectations

E: Failure – little to no demonstrated understanding of the material; exceptionally weak performance

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.

Scheduled Topics/Activities

Foundations of Geometric Optics

1. Stops and pupils; marginal and chief rays; field of view; Lagrange invariant.
2. Determination of pupil location by Gaussian optics and raytracing; numerical aperture; f-number.
3. Vignetting; real ray traces; afocal systems
4. ABCD Matrices

Elementary Optical Systems

5. Simple magnifier; magnifying power.
6. Keplerian telescope; eye relief; field lenses; eyepieces; Galilean telescope; mirror systems.
7. Image erection and relay systems; microscopes.
8. Telecentric systems; imaging properties of afocal systems.
9. Eye
10. Camera Systems; depth of focus and field; image quality; photographic systems; viewfinders and focusing aids; autofocus systems; autocollimator; scanners.

Optical Materials and Dispersion

11. Materials; glass properties; Abbe number; other optical materials.
12. Dispersing prisms; minimum deviation; index measurement; thin prisms; combinations of thin prisms; achromatic prism; direct vision prism, spectrometers.
13. Chromatic effects; longitudinal chromatic aberration; thin lens achromat.

Other Optical Systems

14. Radiometric Transfer; AΩ product; camera equation.
15. Illumination systems; diffuse illumination; projection condenser system; Kohler illumination; critical illumination; slide projector.
16. Light Sources; integrating sphere and bars; practical considerations; dark field and Schlieren systems; overhead projector; Fresnel lenses; optical fabrication techniques; grinding and polishing; spherometer

Classroom Behavior Policy

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.).

Threatening Behavior Policy

The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students.

Accessibility and Accommodations

At the University of Arizona we strive to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability or pregnancy, you are welcome to let me know so that we can discuss options. You are also encouraged to contact Disability Resources (520-621-3268) to explore reasonable accommodation.

If our class meets at a campus location: Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.

Code of Academic Integrity

Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog. See: http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity.

Students enrolled in academic credit bearing courses are subject to this Code. Conduct prohibited by this Code consists of all forms of academic dishonesty, including, but not limited to:

1. Cheating, fabrication, facilitating academic dishonesty, and plagiarism as set out and defined in the Student Code of Conduct, ABOR Policy 5-308-E.10, and F.1

2. Submitting an item of academic work that has previously been submitted or simultaneously submitted without fair citation of the original work or authorization by the faculty member supervising the work.

3. Violating required disciplinary and professional ethics rules contained or referenced in the student handbooks (hardcopy or online) of undergraduate or graduate programs, or professional colleges.

4. Violating discipline specific health, safety or ethical requirements to gain any unfair advantage in lab(s) or clinical assignments.

5. Failing to observe rules of academic integrity established by a faculty member for a particular course.

6. Attempting to commit an act prohibited by this Code. Any attempt to commit an act prohibited by these rules shall be subject to sanctions to the same extent as completed acts.

7. Assisting or attempting to assist another to violate this Code.

The University Libraries have some excellent tips for avoiding plagiarism, available at http://new.library.arizona.edu/research/citing/plagiarism.

Selling class notes and/or other course materials to other students or to a third party for resale is not permitted without the instructor's express written consent. Violations to this and other course rules are subject to the Code of Academic Integrity and may result in course sanctions. Additionally, students who use D2L or UA e-mail to sell or buy these copyrighted materials are subject to Code of Conduct Violations for misuse of student e-mail addresses. This conduct may also constitute copyright infringement.

UA Nondiscrimination and Anti-harassment Policy

The University is committed to creating and maintaining an environment free of discrimination; see http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy

Our classroom is a place where everyone is encouraged to express well-formed opinions and their reasons for those opinions. We also want to create a tolerant and open environment where such opinions can be expressed without resorting to bullying or discrimination of others.

Additional Resources for Students

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

Student Assistance and Advocacy information is available at http://deanofstudents.arizona.edu/student-assistance/students/student-assistance

Confidentiality of Student Records

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

Subject to Change Statement

Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.

References and Other Resources

Optics of the Human Eye	Atchison & Smith
Optical Instrumentation	Begunov at al
Field Guide to Lens Design	Bentley and Olson
Radiometry and the Detection of Optical Radiation	Boyd
Geometrical and Trigonometric Optics	Dereniak
Modern Geometrical Optics	Ditteon
Seeing the Light	Falk, Brill & Stork
Optical System Design	Fischer, et al.
Camera Technology - The Dark Side of the Lens	Goldberg
Field Guide to Radiometry	Grant
Optics	Hecht
Schaum's Outline of Theory and Problems in Optics	Hecht
Building Electro-Optical Systems	Hobbs
Fundamentals of Optics	Jenkins & White
Optics and Optical Instruments	B. K. Johnson
Optical Systems Engineering	Kasunic
Introduction to Geometrical Optics	Katz
Fundamental Optical Design	Kidger
History of the Telescope	King
Optical System Design	Kingslake
History of the Photographic Lens	Kingslake
Lens Design Fundamentals	Kingslake
Optics in Photography	Kingslake
Lens Design	Laikin
Optical Imaging and Aberrations	Mahajan
Geometrical and Instrumental Optics	Malacara
Handbook of Lens Design	Malacara & Malacara
Geometrical Optics and Optical Design	Mouroulis & Macdonald
Visual Instrumentation	Mouroulis
Elements of Modern Optical Design	O'Shea
Art of Radiometry	Palmer and Grant
Introduction to Optics	Pedrotti & Pedrotti

Mirror, Mirror	Pendergrast
Applied Photographic Optics	Ray
Scientific Photography and Applied Imaging	Ray
Fundamentals of Photonics	Saleh & Teich
Aberrations in Optical Imaging Systems	Sasián
The Science of Imaging	Saxby
Field Guide to Visual and Ophthalmic Optics	Schwiegerling
The Art and Science of Optical Design	Shannon
Modern Lens Design	W. Smith
Practical Optical System Layout	W. Smith
Modern Optical Engineering - the Design of Optical Systems; Fourth Edition	Warren J. Smith
The Eye and Visual Optical Instruments	G. Smith & Atchison
Concepts of Classical Optics	Strong
Optical Engineering Fundamentals	Walker
Useful Optics	Welford
Aberrations of Optical Systems	Welford
Infrared Handbook	Wolfe
Optical Engineer's Desk Reference	Wolfe
Handbook of Optics	Optical Society of Am.
Military Handbook 141 - Optical Design	Department of Defense
Basic Optics and Optical Instruments	Bureau of Naval Pers.
Optics Source Book Schott Glass Catalog	McGraw Hill

My signature below confirms that I have read and understand the policies in this syllabus and agree to follow them in taking OPTI 202R in Spring 2023.

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Signature **Date**

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Print Name