THE UNIVERSITY OF ARIZONA

SYLLABUS

OPTI 502
Optical Design and Instrumentation

Mondays and Wednesdays 2:00 PM – 3:15 PM, Meinel 307

Description of Course

This course will provide the student with a fundamental understanding of optical system design and instrumentation. The course begins with the foundations of geometrical optics, which includes the first-order properties of systems, and paraxial raytracing, continues with a discussion of elementary optical systems, and concludes with an introduction to optical materials and dispersion. A special emphasis is placed upon the practical aspects of the design of optical systems.

Topics covered:

This course will teach the student four main factors relating to image formation in geometrical optics:

Foundations of Geometric Optics

1. Assumptions of geometrical optics; refractive index; optical path length; rays and wavefronts; Fermat's principle; Snell's law; refraction and reflection; critical angle; sign conventions.
2. Plane mirrors; systems of plane mirrors; parity and orientation.
3. Non-dispersing prisms and prism types; plane-parallel plate; tunnel diagrams; reduced thickness.
4. Imaging with a thin lens; focal length; conjugates; magnification; imaging equations.
5. Real and virtual images; negative lenses; thin-lens afocal systems.
6. Imaging and optics; optical spaces; principal planes; paraxial refraction equation; power and focal lengths of general systems.
7. Gaussian imagery; magnification; cardinal points and planes; Newtonian and Gaussian equations; conjugate planes; afocal systems.
8. Object-image relationships and zones; longitudinal magnification; colinear transformation.
9. Transfer between surfaces; two component systems; Gaussian reduction.
10. Single reflecting surface; thick lens; thin lens; systems of two thin lenses.
11. Paraxial ray tracing; cardinal points by raytracing; back focal distance; virtual objects.
12. Stops and pupils; marginal and chief rays; field of view; Lagrange invariant.
13. Pupil location by Gaussian optics and raytracing; numerical aperture; f-number.
14. Vignetting; real ray traces.
15. Radiometric Transfer; AΩ product; camera equation.

Elementary Optical Systems

16. Objectives; collimators; depth of focus and hyperfocal distance; Scheimpflug condition.
17. Zoom lenses; simple magnifier; magnifying power.
18. Keplerian telescope; eye relief; field lenses; eyepieces; Galilean telescope; mirror systems.
19. Image erection and relay systems; microscopes.
20. Telecentric systems; imaging properties of afocal systems.
21. The stop and its effects on image quality and system performance.

Additional possible topics

22. Glass properties; dispersion and Abbe number; other optical materials.
23. Dispersing prisms; minimum deviation; index measurement; prism spectrometer.
24. Thin prisms; combinations of thin prisms; achromatic prism; direct vision prism.
25. Longitudinal chromatic aberration; thin lens achromatic doublet; rainbows.

Instructor and Contact Information

Instructor:

Dr. Felipe Guzman, Professor of Optical Sciences
Office: GCRB 307
Email: felipeguzman@arizona.edu
Office hours: upon request

Teaching Assistant:

Charlie Chisholm
Email: cchisholm@arizona.edu
Office hours: Tu, We 3:30 – 4:30 pm
Room: Meinel 654

Assignments and Examinations:

- **Grading:**
  - Homework: 20%
  - Quizzes / Surveys: 5%
  - 2 Midterm Exams: 20% each = 40%
  - Final Exam: 35%
  - Corrections to errors in grading will only be considered within one week following the return of the exam.
- **Homework:**
  - Homework assignments and their DUE dates will be posted on our on-line Syllabus.
  - Homework assignments will be submitted though D2L.
  - Homework turned in after it has been collected may not be accepted.
- **Quizzes:**
  - We will do a few graded pop quizzes and surveys throughout the semester.

Suggested Reading

These books are on reserve in the Optical Sciences Library):

- John E. Greivenkamp, *Field Guide to Geometrical Optics* (SPIE Press)
  http://ezproxy.library.arizona.edu/login?url=http://dx.doi.org/10.1117/3.547461
- Warren J. Smith, *Modern Optical Engineering* (SPIE Press)
  https://ebookcentral.proquest.com/lib/uaz/detail.action?docID=4656882
- Eugene Hecht, *Optics* (Addison-Wesley Publishing Company)

Final Examination

The Final Exam has been scheduled for Friday, December 13th, 2024, 1 – 3 pm.

Grading Scale and Policies

The grading system for this course will result in grades from A (excellent) through E (failure).

Grading Scale:

85-100%: A
75-85% : B
65-75% : C
50-65% : D
<50% : E

Attendance Policy:

It is important to attend all classes, as what is discussed in class is pertinent to adequate performance on assignments and exams. If you must be absent, it is your responsibility to obtain and review the information you missed. Unannounced quizzes will be given to encourage attendance, and to help you gauge your progress in learning the material.

If you miss the midterms or final exam, they may not be made up unless you have a documented medical or family emergency.

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.

Important dates

Date	Event	Comments	Notes
2024-08-26	First day of classes	Syllabus and timeline	
2024-09-02	Labor Day	No classes on Monday 09/02	
2024-09-24/26	Recorded Lectures	Due to travel	
2024-10-07	Review session prior to Midterm I	Practice problems	TBC
2024-10-09	Midterm I	All material until 2024-10-02	TBC
2024-11-04	Review session prior to Midterm II	Practice problems	TBC
2024-11-06	Midterm II	All material until 2024-10-30	TBC
2024-11-11	Veterans Day	No classes on Monday 11/11	
2024-11-25/27	Thanksgiving week	No classes	
2024-12-9/11	Last week of classes	Review sessions for Final Exam	TBC
2024-12-13	**FINAL EXAM**	Friday 2024-12-13, 1 – 3 pm	

TBC: To be confirmed.

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.

Selling class notes and/or other course materials to other students or to a third party for resale is not permitted under any circumstances. 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.

Also, students using images from the internet without citation is considered an act of plagiarism. If you have any questions regarding this, please see the instructor. The University Libraries have some excellent tips for avoiding plagiarism. See:

http://new.library.arizona.edu/research/citing/plagiarism.

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.

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.

Absence & Class Participation Policy

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 laboratory sessions. 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.

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

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.

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.

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.).

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.