OPTI 330
Physical Optics II

Instructor: Professor Amit Ashok
Lecture Hours: M/W: 1:00pm - 2:15pm
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TA: Ms. Micaehla May
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OPTI330. Physical Optics II (3). Linear system theory, Fourier optics, Interference and diffraction, Image formation, Optical transfer function. P, OPTI 310.

1 Course Objectives

1. Learn linear system theory.

2. Learn the Fourier transform and its properties.

3. Understand discrete representation of continuous signals.

4. Learn to manipulate discrete signals on a computer.

5. Understand diffraction and image formation using physical optics principles.

6. Understand the principles of Fourier optics.

7. Become proficient in analyzing optical systems using linear system theory.

2 Class Notes and Textbook

Course notes will be provided for all the lectures, free of charge via the class D2L website. The following field handbook is highly recommended and available free of cost to UA students via the following link:

- J. S. Tyo and A. Alenin, "Field Guide to Linear Systems in Optics," SPIE Press, ISBN: 9781628415.
  `https://www-spiedigitallibrary-org.ezproxy2.library.arizona.edu/ebooks/FG/`
  `Field-Guide-to-Linear-Systems-in-Optics/eISBN-9781628415483/10.1117/3.1002932?SSO=1`

Supplementary/reference reading materials for this course include:

- J.D. Gaskill, "Linear Systems, Fourier Transform, and Optics," John Wiley and Sons, 1978.

- J. W. Goodman, "Introduction to Fourier Optics, second edition," McGraw Hill, New York, 1996.

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. Providing student email addresses to a third party is not permitted. 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 email to sell or buy these copyrighted materials are subject to Code of Conduct Violations for misuse of electronic resources provided by The University of Arizona. This conduct may also constitute copyright infringement.

3 Course Website

The course will be delivered remotely via the University of Arizona's D2L software system and Zoom meeting platform. The D2L can by accessed by this link: `www.d2l.arizona.edu`

Log in using your UA NetID, and you will see a list of all classes that use D2L. All homework assignments, Matlab assignments, homework solutions, announcements, etc., will be made through D2L. Please check D2L periodically for updates during the semester.

4 Homework Policy

There will be *weekly homework assignments* and the due date in *most* cases will be one week from the date of assignment. All homework assignments are to be submitted to D2L in a designated folder by the due date and time. All homework assignments will have a due date and a late due date. There will be a *20% reduction* in the score for assignments turned in after the initial due date. No assignments will be accepted after the late due date, unless prior arrangement with the instructor has been made. Students may drop their LOWEST homework assignment score.

5 Matlab Assignments

There will be assignments in the latter part of the course that will involve Matlab to model optical phenomenon and optical systems. Matlab is available free to all UA Students and employees. If you would prefer to use another computational package (e.g. Octave, Mathematica), you should arrange that with the instructor. Late assignments will be accepted up to the late due date with a *20% reduction* in grade. Students may drop their LOWEST Matlab assignment score.

6 Examinations

There will be a 75 minutes midterm examination on the following date:

- 03/01/2023 - **Mid-term** - Monday (subject to change)

The final will be a cumulative 2-hour examination:

- 05/08/2023 - Monday

7 Grading

The final grade for the class will have following components:

1. Class attendance and participation: 5%

2. Homework/Matlab Assignments: 35%

3. Midterm Exam: 30%

4. Final Exam: 30%

8   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.

9   Academic Integrity

Integrity and ethical behavior are expected of every student in all academic work. This Academic Integrity principle stands for honesty in all class work, and ethical conduct in all labs and clinical assignments. This principle is furthered by the student Code of conduct and disciplinary procedures established by **ABOR Policies 5-308 through 5-404**, all provisions of which apply to all University of Arizona students. The Code of Academic Integrity is intended to fulfill the requirement imposed by **ABOR Policy 5-403.A.4** and otherwise to supplement the Student Code of Conduct as permitted by **ABOR Policy 5-308.C.1**.

For more details please see:
http://deanofstudents.arizona.edu/codeofacademicintegrity

You are expected and encouraged to consult with your colleagues in the preparation of your homework assignments. As I stated above, homework assignments are for the benefit of the student, so if you do not understand the homework you are the only one that will suffer. However, please do not insult your colleagues, the grader, or me by turning in directly copied homework. If you work with a colleague closely enough that your solutions might appear (legitimately) to be copied, then please disclose the collaboration on the top of the page. It is quite acceptable to consult references, other course notes, other faculty, senior graduate students, etc., in preparing your solutions. However, any consultation with an outside source that contributes significantly to the solution you turn in should be disclosed.

Examinations are to be your own work and exclusively your own work.

Topics Covered

1. **Mathematical and Physical Background (2 weeks)**

    (a) Introduction: Maxwell Equations, Diffraction

    (b) Complex numbers

    (c) Signals and Special functions

2. **Linear Systems Theory (2 Weeks)**

    (a) Linear Shift Invariant (LSI) Systems

    (b) Convolution and Correlation operators

    (c) Relation to scalar and Fresnel Diffraction

3. **Fourier Transforms, Linear Systems, and Filtering (3 weeks)**

    (a) Fourier series

    (b) Fourier transform and its properties

    (c) Convolution theorem

    (d) Relation to Fraunhofer Diffraction

4. **Sampling and Discrete Signal Processing (2 weeks)**

    (a) Sampling theorem and reconstruction

    (b) Discrete Fourier Transform (DFT) and its properties

5. **Diffraction and Propagation (3 weeks)**

    (a) Wave propagation and coherence

    (b) Fresnel diffraction

    (c) Fraunhofer diffraction

    (d) Diffraction from lenses

6. **Diffraction Effects in Imaging Systems (3 weeks)**

    (a) Image formation

    (b) Fourier optics and frequency domain description

    (c) Coherence and resolution