# Fourier Optics   EE383P

**COURSE INFORMATION**

**Class meets T Th 2:00 – 3:30 pm  GDC 5.304**

**Prerequisite:** Working understanding of Signals and Systems (especially Fourier Transforms), or consent of the Instructor.

**Course Description:** Fourier optics is the study of how concepts from linear and space-invariant systems can provide powerful descriptors of how optical waves propagate. The Fourier transform is one such powerful descriptor, and is of great utility in decomposing electric fields into their harmonic plane-wave components. This enables rigorous understanding of how light propagates within instruments composed of linear optical elements, such as is the case with microscopes, telescopes, and cameras. Fourier optics also introduces a coherent-analysis framework, which enables rich analysis and understanding of illumination sources ranging from modulated lasers to incoherent white-light sources. Light coherence also has applications for optical information processing and holography. Lastly, Fourier Optics also presents a theoretical foundation for diffraction theory, which allows one to calculate and predict imaging resolution and other interference-based phenomena.

**General Syllabus:**

1. Introduction to 2-D Linear Systems (Text Ch. 2)
2. Scalar Diffraction Theory (Ch. 3)
3. Fourier Transforming Properties of Lenses (Ch. 6)
4. Fourier Analysis of Imaging Systems (Ch. 7)
5. Optical Information Processing (Ch. 10 )
6. Fourier Optics Applications (Ch. 11 and miscellaneous)

**Instructor:** Prof. Shwetadwip Chowdhury: shwetadwip.chowdhury@utexas.edu
**Teaching Assistant:** TBD

**Office Hours:** Tuesday, 10:00-11:30 in EER 5.808

**Textbook:** Joseph W. Goodman, Introduction to Fourier Optics 4$^{th}$ ed., MacMillan Learning, 2017

**Course work:** All students will do a class project in teams of two-three students involving a simulation of an optical system employing topics from Fourier optics. The one project report per team will be a paged-limited memo type report, and both team members will receive the same grade.

**Homework:** Consists mostly of problems from Goodman book. Generally due on the first lecture after the set of lectures covering the relevant content. Late homework is worth 2/3 when turned in one class late, 1/3 when a week late, and zero thereafter.

**Grading:**

1. 2 exams. 25% ea.
2. Homework problem assignments. 25% in total
3. Group project, simulation using computational techniques and report on results (due on last day of class). 25%

**Scholastic Dishonesty:**
UT policy will be followed. This is not intended to tell you that it won't be tolerated (it won't), but to tell you what is permissible and what is not.

Homework: conferring with others is allowed, but what you submit must be your own work (not copied). For the project, one common version is submitted. What you submit must be the team's own work, programs, results, etc., **or** it must be referenced properly. If it's not referenced, and it's not yours, then it is plagiarism. I do encourage consulting all sources that you can (including your uncle at IBM) so long as those sources are acknowledged. Be careful to cite web sources completely as well.

Exams: Note sheets and programmable calculators are allowed for the exams. Any exchange of information (one-way or two-way) outside of you, your note sheet, and your calculator during the exam is obviously NOT OK. Prior knowledge of exam questions is also NOT OK.

**Fourier Optics - ECE 383P Syllabus Fall 2024 | T Th 2:00 - 3:30pm**

| Class # | Day | | Topics | Reading Chapter (4th ed); Assignment due |
|---|---|---|---|---|
| | | | | |
| 1 | T | 27-Aug | Intro + Fourier Transform (FFT) basics | 2 |
| 2 | Th | 29-Aug | Properties of FFTs and Linear, Space Invariant (LSI) Systems | 2 |
| 3 | T | 3-Sep | Scalar Diffraction theory | 3 |
| 4 | Th | 5-Sep | Scalar Diffraction theory | 3 |
| 5 | T | 10-Sep | Scalar Diffraction theory | 3; HW #1 due |
| 6 | Th | 12-Sep | Angular Spectrum | 3 |
| 7 | T | 17-Sep | Angular Spectrum | 3 |
| 8 | Th | 19-Sep | Fresnel & Fraunhofer Diffraction | 4 |
| 9 | T | 24-Sep | Fresnel & Fraunhofer Diffraction | 4; HW #2 due |
| 10 | Th | 26-Sep | Fresnel & Fraunhofer Diffraction *(potentially virtual or guest lecture)* | 4 |
| 11 | T | 1-Oct | Fraunhofer Diffraction | 4 |
| 12 | Th | 3-Oct | Fraunhofer Diffraction and gratings | 6 |
| 13 | T | 8-Oct | Fourier-transform properties in Lenses | 6; HW #3 due |
| 14 | Th | 10-Oct | Fourier-transform properties in Lenses | 6 |
| 15 | T | 15-Oct | Exam #1 (FFT/LSI + Scalar Diffraction + Fresnel/Fraunhofer) | |
| 16 | Th | 17-Oct | Imaging with Lens-based of imaging systems | 7 |
| 17 | T | 22-Oct | Fourier analysis of imaging systems (introducing project/ entrance and exit pupil functions) | 7 |
| 18 | Th | 24-Oct | Fourier analysis of imaging systems (pupil and transfer functions) | 7 |
| 19 | T | 29-Oct | Fourier analysis of imaging systems (4f-system/spatial filtering) | 7; HW #4 due |
| 20 | Th | 31-Oct | Fourier analysis of imaging systems (temporal and spatial coherence) | 7 |
| 21 | T | 5-Nov | Fourier analysis of imaging systems (coherence continued) | 7 |
| 22 | Th | 7-Nov | Demo (interferometer and coherent/incoherent resolution analysis) | N/A |
| 23 | T | 12-Nov | Fourier Optics Applications (Structured illumination microscopy) | N/A; HW #5 due |
| 24 | Th | 14-Nov | Fourier Optics Applications (Off-axis holography and 3D holotomography) | |
| 25 | T | 19-Nov | Exam #2 (Fourier properties of Lenses + System Fourier Analysis) | |
| 26 | Th | 21-Nov | Fourier Optics Applications (Fourier ptychographic microscopy) | |
| 27 | T | 26-Nov | Thanksgiving Holiday | |
| 28 | Th | 28-Nov | Thanksgiving Holiday | |
| 29 | T | 3-Dec | Fourier Optics Applications (DiffuserCam) | N/A |
| 30 | Th | 5-Dec | Guest lecture: Beyond Fourier Optics | N/A |
| N/A | F | 13-Dec | Project Presentations | |