

10 51 452 Imaging Systems II: Resolution, MTF, and spatial artifacts

Instructor:

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Office hours: F 2:00-3:00 or by appointment

Class schedule:

M-W-F 10:00-10:50

Lab. Schedule

W 6:00-6:50

Goals of the course:

To provide the student with practical skills in the mathematical analysis and modeling of spatial characteristics of complex imaging systems. Students will be able to apply these skills to the practical analysis of image quality, information content, and resolution. Students will learn to measure MTF and CTF and to apply convolution and Fourier techniques to both linear and non-linear sequences of imaging processes for both discrete and continuous processes. **Prerequisites:** 10 51 320 Linear Mathematics for Imaging. 10 51 451 Imaging systems Analysis I: TTF and 10 51 455 Physical Optics are useful but not necessary.

Text, references, etc.:

Notes provided by the instructor.

Easton, R L. Linear Mathematics and its Application to Imaging

Outline:

1. Experimental measurement of resolution
 - a. Diffraction, acuity
 - b. Resolution test target
 - c. The impact of gamma on resolution
2. Signal modulation in continuous systems
 - a. PSF, ESF and LSF
 - b. Fourier analysis and the MTF
 - c. Linearity
 - d. Shift-variant and shift-invariant systems.
3. Imaging systems as spatial filters
 - a. Convolution and the Fourier transform
 - b. Impulse response functions
 - c. Low pass, high pass, and band pass filters

- d. Phase filters
- 4. Signal modulation in discrete systems
 - a. Sampling and interpolation
 - b. Infinite-support DFT
 - c. Finite-support DFT, leakage
 - d. Efficient algorithms, FFT
- 5. Propagation of modulation through multiple systems
 - a. Propagation through linear systems
 - b. Simple non-linearity and backing modulation through the TTF
 - c. Intrinsic non-linearity and stepwise modeling of modulation
 - d. Simplifying approximations and the CFT.

Labs

- 1. 1D convolution
- 2. Parametric Modeling of the PSF and MTF
- 3. FFT analysis of the MTF
- 4. A Point Spread Function in a Non-Linear System
- 5. Analysis of a Complete System

Course evaluation:

Lab + HW 30%

Midterm exam 30%

Final exam comprehensive 40%

No late assignments, no makeup exams.

Course schedule:

December

Week 1	12/4 Diffraction and Resolution	12/6 Diffraction and Resolution	12/8 Diffraction and Resolution HW 1
Week 2	12/11 LSI Systems	12/13 Convolution	12/15 Convolution HW 1 due HW 2
Week 3	12/18 Convolution Properties	12/20 Convolution Properties Lab 1	12/22 Special Functions

January

Week 4	1/8 Special Functions HW 2 due	1/10 Correlation	1/12 Fourier Transform Lab 1 due
Week 5	1/15 Midterm Exam	1/17 PSF, LSF, ESF, MTF HW 3 Lab 2	1/19 Fourier Transform
Week 6	1/22 Fourier Transform Theorems	1/24 Fourier Transform Theorems Filtering HW 3 due Lab 3	1/26 Filtering Lab 2 due HW 4
Week 7	1/29 Sampling	1/31 Sampling	2/2 Interpolation Lab 3 due HW 4 due

February

Week 8	2/5 Sampling	2/7 Sampling Interpolation HW 5	2/9 DFT infinite support Lab 4 due
Week 9	2/12 DFT finite support Leakage	2/14 Lab 4 Lab 5 FFT HW 5 due HW 6	2/16 FFT
Week 10	2/19 Propagation of Modulation	2/21 Propagation of Modulation HW 6 due	23 Propagation of Modulation Lab 5 due
Finals	Final exam. Lab 4 due		

