MSE 7193.02 IMAGE SCIENCE  (Spring 2020)

1. Introduction:
Catalog data:  1 Cr. Hr,  
 Wednesday 3:00- 4:30PM (CEMAS)

Instructor:  Jinwoo Hwang  
 CEMAS: 1305 Kinnear Rd.  
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Course web-site:  Canvas

Office hours:  CEMAS, Appointment based

Purpose:
This course presents the conceptual and mathematical foundations of data processing of multi-
dimensional scientific experimental data, including electron microscopy images and diffraction
patterns. The goal is to cover various topics related to the mathematical and practical aspects of
current state-of-the-art image processing and data analysis techniques that are not covered by any
of the existing characterization-related courses in our graduate curriculum.

The topics in this course will include:

- Basic understanding and application of Fourier transformation, for filtering and
  processing of 1D (graphs), 2D (images and diffraction patterns), and 3D data (image
  stacks and “big data”).
- Noise analysis and filtering, and understanding of experimental uncertainties in images.
- Aliasing – how to understand and prevent it.
- Basic and advanced functionality of scientific image processing programs, including
  ImageJ, Digital Micrograph, and Igor Pro.
- Image intensity quantification at the atomic scale.
- Non-rigid registry of STEM data for high precision atomic scale imaging.

2. Books:

Recommended books:
- Digital Image Processing (3rd or 4th); Rafael C. Gonzalez and Richard E. Woods
- Foundations of Image Science (1st); Harrison H. Barrett and Kyle J. Myers
- Fourier Analysis and Its Applications; Gerald B. Folland
- Williams and Carter, Chapter 31.

No need to buy any of these books unless you really want (they are rather expensive).  I will try
to scan relevant sections individually and upload them on Carmen if necessary.

3. Course Policies:

   i) Grade policy:
      a) **Numerical scores**: The total weight of the course is *approximately* divided as follows:
         Homework  50%
Final Report 50%

b) Letter grades will be determined by student’s performance relative to the class average.

ii) Homework will be assigned periodically. It will be collected, graded and solutions will be provided on Carmen.

4. Class schedules and Approximate list of topics

Wk1 (1/10)
- Basics of digital imaging
- Real space image transformations and filtering (ImageJ demonstration)

Wk2 (1/17)
- Fourier series and transform

Wk3 (1/24)
- Fourier series and transform (continued)
- Convolution
- Other basic functions and math operations

Wk4 (1/31)
- Fourier transformation (FT) properties
- Discrete FT

Wk5 (2/7)
- FT in 2-dimension
- Fourier filtering (Digital Micrograph demonstration)

Wk6 (2/14)
- Aliasing and sampling in digital imaging

Wk7 (2/21)
- Image quantification in real space using actual scientific data
- How to deal with image stacks (ImageJ demonstration)
- Rigid registration of 2D data
- Non-rigid registration of 2D data

Final report due by 2/27.

5. Academic Integrity, Academic Misconduct
Academic misconduct may be found in any action that tends to distort the accurate assessment of any student’s individual accomplishments that are evaluated for the purpose of grading or conferring academic credit. Note that a student may be guilty of academic misconduct, for example, by cheating, collaborating, plagiarizing, or by allowing another student to cheat, collaborate, or plagiarize. Note also that the distortion applies, for example, to exams, homework assignments, and laboratory work. To the extent that any class activity (for example: attendance or participation) is used for evaluation for the purpose of grading or conferring academic credit,
falsifying or distorting such activity, or permitting another student to falsify or distort such activity, represents academic misconduct.

Additional guidance about what represents academic integrity and misconduct, and related university-wide policies and procedures are available at the following locations:

http://oaa.osu.edu/coam/faq.html
http://oaa.osu.edu/coam/ten-suggestions.html

Note: Students should not request nor accept guidance on these matters from a teaching assistant, fellow student, or anyone other than the faculty instructor of record for this course.

6. Disabilities Statement
Any student who feels s/he may need an accommodation based on the impact of a disability should contact the Office for Disability Services at 614-292-3307 in room 150 Pomerene Hall to coordinate reasonable accommodations for students with documented disabilities. (URL: http://www.ods.ohio-state.edu/). Advice on such matters is also available from:

Megan Daniels, Undergraduate Advisor, (614) 292-3145, e-mail Megan concerning the MSE undergrad studies.

Mark Cooper, Graduate Studies Coordinator, (614) 292-7280, e-mail Mark concerning the MSE graduate studies.