

**University of Utah**  
**Course Outline for 3D Reconstruction BE7320/EE7320**

**Spring 2000**

***I. Mathematics of 2D Reconstruction***

- 1 (Jan 10 M) Introduction, Delta function and Fourier Transform
- 2 (Jan 12 W) Projection, Back-projection and the Central Slice Theorem
- 3 (Jan 14 F) Parallel beam Reconstruction 1  
(Jan 17 M) MLK Holiday
- 4 (Jan 19 W) Discrete 2D Reconstruction Implementations
- 5 (Jan 21 F) Fan Beam Reconstruction 1

***II. Medical Imaging Modalities***

- 6 (Jan 24 M) X-ray CT
- 7 (Jan 26 W) Fan Beam 2
- 8 (Jan 28 F) SPECT (Single Photon Emission Computed Tomography) and PET (Positron Emission Tomography)
- 9 (Jan 31 M) Computer Lab 1
- 10 (Feb 2 W) PET and MRI (cont'd). Additive Noise
- 11 (Feb 4 F) (Poisson) Noise Propagation in the Filtered Back-Projection Algorithm
- 12 (Feb 7 M) Attenuation Correction Algorithms
- 13 (Feb 9 W) Review

**(Feb 11 F) Test 1**

***III. Iterative Algorithms (2D and 3D)***

- 14 (Feb 14 M) ART (Algebraic Reconstruction Techniques)
- 15 (Feb 16 W) The Conjugate Gradient Algorithm and Maximum Entropy
- 16 (Feb 18 F) Maximum Likelihood Objective Functions
- 17 (Feb 22 T) The EM Algorithm
- 18 (Feb 23 W) Ordered Subsets and Maximum A Posteriori methods
- 19 (Feb 25 F) Dynamic Imaging (4D) Reconstructions
- 20 (Feb 28 M) Computer Lab 2

***IV. Mathematics of 3D Reconstruction***

- 21 (Mar 1 W) Introduction 1: Notations and X-ray projections
  - 22 (Mar 3 F) Introduction 2: Radon Projections
  - 23 (Mar 6 M) Reconstruction from Radon Projections
  - 24 (Mar 8 W) Review
- (Mar 10 F) Test 2**
- March 13-17 – Spring break
- 25 (Mar 20 M) Reconstruction from X-Ray Projections 1: Orlov's Condition
  - 26 (Mar 22 W) Reconstruction from X-Ray Projections 2: Backprojection Filtering
  - 27 (Mar 24 F) Reconstruction from X-Ray Projections 3: FBP
  - 28 (Mar 27 M) Computer Lab 3 – Truncated projections
  - 29 (Mar 29 W) Reconstruction from X-Ray Projections 4: Filters
  - 30 (Mar 31 F) 3D PET – truncated data, 3DRP
  - 31 (Apr 3 M) Work on project – no class
  - 32 (Apr 5 W) 3D PET - Rebinning
  - 33 (Apr 7 F) Cone Beam Tomography 1: Feldkamp Algorithm
  - 34 (Apr 10 M) Cone Beam Tomography 2: Data Sufficiency Conditions
  - 35 (Apr 12 W) Cone Beam Tomography 3: Grangeat's Formula
  - 36 (Apr 14 F) Cone Beam Tomography 4: Radon Method and Implementation

***V. Advanced Topics***

- 37 (Apr 17 M) Vector Tomography
  - 38 (Apr 19 W) Vector Tomography with boundary conditions
  - 39 (Apr 21 F) Presentation of Projects
  - 40 (Apr 24 M) Presentation of Projects
  - 41 (Apr 26 W) Review
- Final - week of May 1

**Instructors:**

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**Policies:**

Homework will be assigned approximately weekly. Any homework you turn in is expected to be your own work, without help from anyone except the course instructors. You are encouraged to come by my office or send me email for hints and help. Late homework will not be accepted.

The homework will also often include problems which require computer implementations. For these problems, you are free to discuss the problems and help one another. Matlab is the recommended tool but you are free to use any software package you like or programming languages such as C.

**Grading:**

Homework	20%
Test #1	20%
Test #2	20%
Project	15%
Final Exam	25%

**Some Important Dates:**

January 16	Drop day (without appearing on transcript)
January 21	Last day to withdraw without payment for course
February 22 (Tuesday)	Substitute day (for MWF classes)
March 3	Last day to withdraw

**Text:**

Draft chapters from the book Dr. Rolf Clackdoyle is writing on 3D Tomography, and other handouts.

**References:**

Kak, A. C. and M. Slaney (1987). Principles of Computerized Tomographic Imaging, IEEE Press.

Bracewell, R. N. (1995). Two-dimensional Imaging. Englewood Cliffs, NJ, Prentice-Hall, Inc.

Deans, S. R. (1983). The Radon Transform and Some of its Applications, John Wiley & Sons.

Jain, A. K. (1989). Fundamentals of Digital Image Processing (ch.10). Englewoods Cliffs, NJ, Prentice Hall.

Macovski, A. (1983). Medical Imaging Systems, Prentice-Hall, Inc.