ROCHESTER INSTITUTE OF TECHNOLOGY
COURSE OUTLINE FORM

COLLEGE OF SCIENCE

Chester F. Carlson Center for Imaging Science

NEW COURSE: COS-IMGS-797 - Principles of Computed Tomographic Imaging

1.0 Course Approvals

Required course approvals:	**Approval request date:**	**Approval granted date:**
Academic Unit Curriculum Committee	8/30/2010	9/15/2010
College Curriculum Committee	9/28/2011	10/12/11

Optional designations:	**Is designation desired?**		***Approval request date:**	****Approval granted date:**
General Education:		No		
Writing Intensive:		No		
Honors		No		

2.0 Course information:

Course title:	Principles of Computed Tomographic Imaging
Credit hours:	3
Prerequisite(s):	IMGS-616 or permission of instructor
Co-requisite(s):	None
Course proposed by:	Navalgund Rao
Effective date:	Fall 2013

	Contact hours	**Maximum students/section**
Classroom	3	20
Lab		
Studio		
Other (specify)		

2.1 Course Conversion Designation (Please check which applies to this course)

X	Semester Equivalent (SE) Please indicate which quarter course it is equivalent to: 1051-797 Principles of Computed Tomographic Imaging
	Semester Replacement (SR) Please indicate the quarter course(s) this course is replacing:
	New

2.2 Semester(s) offered (check)

Fall	Spring X	Summer	Other

All courses must be offered at least once every 2 years. If course will be offered on a bi-annual basis, please indicate here: X

2.3 Student Requirements

Students required to take this course: None
Students who might elect to take the course: Graduate students in Imaging Science who are in Medical Imaging track. Other graduate students in Imaging Science, College of Science, or College of Engineering.

3.0 Goals of the course (including rationale for the course, when appropriate):

3.1 To give students an in depth understanding of how images are computationally constructed from raw CT data.

3.2 To provide the physical basis for each of the modern CT-based modalities such as x-ray CT, SPECT, and PET.

4.0 Course description

IMGS-797 **Principles of Computed Tomographic Imaging**

Image construction from projections is introduced as a mathematical problem in this course. Techniques for image construction are explained using the Fourier slice theorem. Pure and filtered back-projection and iterative methods are introduced and analyzed. Algorithms for various techniques are developed. Artifacts and noise in discrete cases are considered. Applications to several medical imaging modalities (x-ray CT, PET, SPECT, MRI) are outlined with consideration of the physics involved in each case. (COS-IMGS-616 or permission of instructor) **Class 3, Credit 3 (S, alternate years)**

5.0 Possible resources (texts, references, computer packages, etc.)

5.1 Kak and Slaney, *Principles of Computerized Tomographic Imaging*, IEEE Press, New York, NY

5.2 Hsieh, *Computed Tomography: Principles, Design, Artifacts and Recent Advances*, SPIE Press, Bellingham, WA

6.0 Topics (outline):

- 6.1 Review 2D Fourier, Hankel, FFT & DFT Transforms, theorems
- 6.2 Radon Transform
  - 6.2.1 Projections, sonogram & polar representation
  - 6.2.2 Properties (linearity, space-variant, periodicity, rotation etc.)
  - 6.2.3 Examples of RT, PSF
- 6.3 XY space, Radon space, & Fourier space Triad
  - 6.3.1 Fourier slice theorem
  - 6.3.2 Operational connection between three spaces
  - 6.3.3 Examples of functions transforming through the triad
- 6.4 Image reconstruction: parallel projections
  - 6.4.1 Fourier domain method, analytical examples

6.4.2 Consideration for sampled data
6.4.3 Pure back projection
6.4.4 Filtered back-projection method
6.4.5 Filtered back-projection computer implementation
6.4.6 Algebraic reconstruction method (ART)
6.5 Image reconstruction: Fan beam
6.5.1 Fan to parallel re-binning
6.5.2 Equiangular rays
6.5.3 Equal-spaced sampling
6.5.4 Cone beam reconstruction
6.6 X-ray Physics
6.6.1 Production of x-rays
6.6.2 Interaction with matter (tissue)
6.7 Applications: x-ray CT
6.7.1 Line integral & assumptions
6.7.2 5 generation scanners, data sampling & sensors
6.7.3 Helical CT
6.7.4 Image presentation and system PSF, MTF
6.8 CT image artifacts
6.9 Image reconstruction in PET and SPECT
6.10 Image reconstruction in MRI
6.11 Systems analysis approaches

7.0 Intended course learning outcomes and associated assessment methods of those outcomes

Course Learning Outcome	Homework and projects	Exams
7.1 Define the mathematical basis for the image reconstruction in modern medical imaging modalities	X	X
7.2 Describe the computational issues involved	X	X
7.3 Apply linear systems concepts to medical imaging systems	X	X

8.0 Program outcomes and/or goals supported by this course

8.1 Apply knowledge of the science and technology of imaging.
8.2 Prepares graduate students in science and engineering for work in any area of biomedical imaging research.

9.0 N/A

10.0 Other relevant information (such as special classroom, studio, or lab needs, special scheduling, media requirements, etc.)

10.1 Smart classroom
10.2 Whenever possible a visit to a Radiology department is organized.