ROCHESTER INSTITUTE OF TECHNOLOGY
COURSE OUTLINE FORM

COLLEGE OF SCIENCE

Chester F. Carlson Center for Imaging Science

NEW COURSE: COS-IMGS-712 – Multi-view Imaging

1.0 Course Approvals

Required course approvals:	**Approval Requested Date:**	**Approval Granted Date:**
Academic Unit Curriculum Committee	10/11/12	10/12/12
College Curriculum Committee	10/15/2012	11/5/12

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:	Multi-View Imaging
Credit hours:	3
Prerequisite(s):	IMGS-616 or IMGS-682, or permission of instructor
Co-requisite(s):	None
Course proposed by:	Harvey Rhody
Effective date:	Fall 2013

	Contact hours	**Maximum students/section**
Classroom	3	30
Lab		
Studio		
Other (specify)		

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

	Semester Equivalent (SE) Please indicate which quarter course it is equivalent to: 1051-786 Advanced Digital Image Processing
	Semester Replacement (SR) Please indicate the quarter course(s) this course is replacing:
X	New (Previously offered as a special topics course)

2.2 Semester(s) offered (check) [Note: Could be offered either semester]

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:

2.3 Student Requirements

Students required to take this course: None.
Students who might elect to take the course: Graduate students in Imaging Science, the College of Science, or the College of Engineering. This course would serve as a graduate program elective.

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

3.1 To develop basic mathematical and computational knowledge and skills for students in imaging science.
3.2 To develop building-block algorithms and tools with real imaging data using both mathematical and computational exercises and projects.
3.3 To develop proficiency in the multi-view imaging science techniques for use in independent research.

4.0 Course description (as it will appear in the RIT Catalog, including pre- and co-requisites, and quarters offered). Please use the following format:

COS-IMGS-712 **Multi-View Imaging**

Images are 2D projections gathered from scenes by perspective projection. By making use of multiple images it is possible to construct 3D models of the scene geometry and of objects in the scene. The ability to derive representations of 3D scenes from 2D observations is a fundamental requirement for applications in robotics, intelligence, medicine and computer graphics. This course develops the mathematical and computational approaches to modeling of 3D scenes from multiple 2D views. After completion of this course students are prepared to use the techniques in independent research. (Prerequisites: IMGS-616 or IMGS-682, or permission of instructor). **Class 3, Credit 3 (Spring)**

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

5.1 Richard Hartley and Andrew Zisserman, *Multiple View Geometry in Computer Vision*, Cambridge University Press, Cambridge, UK.
5.2 Y. Ma, S. Soatto, J. Kosecka, S. Sastry, *An invitation to 3-D Vision: from Images to Geometric Models*, Springer, New York, NY.

6.0 Topics (outline)

6.1 Cameras and projective geometry
- 6.1.1. The pinhole camera model
- 6.1.2. Homogeneous representation of points
- 6.1.3. Projective transformations
- 6.1.4. Examples of projective distortions

6.2 The 2D projective plane
- 6.2.1. Dual representations of points and lines
- 6.2.2. 2D projective transformations
- 6.2.3. Topology of the projective plane
- 6.2.4. Recovery of affine and metric properties from images
- 6.2.5. Properties of conics

6.3 Points, planes, lines and projective transformations in 3D
- 6.3.1. Representation of points, planes, lines and quadrics in 3D
- 6.3.2. Transformation hierarchy: projective, affine, similarity, Euclidean
- 6.3.3. The plane at infinity
- 6.3.4. The absolute conic
- 6.3.5. The absolute dual quadric

6.4 Camera models and central projection
- 6.4.1. Vanishing points and vanishing lines
- 6.4.2. Computation of the camera matrix P from 3D-2D correspondences
- 6.4.3. Minimization of geometric error
- 6.4.4. Radial distortion modeling and measurement

6.5 Two-view Geometry
- 6.5.1. Epipolar geometry and the fundamental matrix
- 6.5.2. Relationships between the fundamental matrix and camera matrices
- 6.5.3. Projective invariance
- 6.5.4. Computation of the camera matrix from image correspondences
- 6.5.5. Calculating the fundamental matrix from noisy correspondence data
- 6.5.6. Automatic computation of the fundamental matrix and error minimization

6.6 3D Reconstruction of Cameras and Scene Structure
- 6.6.1. Development of the reconstruction strategy
- 6.6.2. Reconstruction from noiseless data
- 6.6.3. Estimation of camera parameters and 3D points from noisy data
- 6.6.4. Iterative refinement: the bundle adjustment approach
- 6.6.5. The Levenberg-Marquardt algorithm
- 6.6.6. Application to 3D reconstruction

6.7 Geometry of three views
- 6.7.1. Trifocal tensor notation and computations
- 6.7.2. Computation of the trifocal tensor
- 6.7.3. Transfer of points among three views
- 6.7.4. Transfer of lines among three views
- 6.7.5. The trifocal tensor and camera matrices
- 6.7.6. The trifocal tensor and the epipolar geometry of any two views

6.8 Applications
- 6.8.1. Computation of dense point clouds
- 6.8.2. 3D reprojection and display
- 6.8.3. Mensuration and calibration

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

Course Learning Outcome	Homework Assignments	Projects	Exams
7.1 Explain perspective projection and its relationship to imaging	X	X	X
7.2 Describe 3D geometry and coordinate transformations	X	X	X
7.3 Apply computational methods with noisy data	X	X	X
7.4 Apply computing tools for computer vision applications		X	

8.0 Program outcomes and/or goals supported by this course

Prepares graduate students in science and engineering for careers in imaging science; multi-view imaging is fundamental to many application areas.

9.0 N/A

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

Smart classroom with Internet access. Also offered online.