ROCHESTER INSTITUTE OF TECHNOLOGY
COURSE OUTLINE FORM

COLLEGE OF SCIENCE

Chester F. Carlson Center for Imaging Science

NEW COURSE: COS-IMGS-754 - Pattern Recognition

1.0 Course Approvals

Required course approvals:	**Approval request date:**	**Approval granted date:**
Academic Unit Curriculum Committee	8/16/10	9/15/10
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:	Pattern Recognition
Credit hours:	3
Prerequisite(s):	IMGS-613 or permission of instructor
Co-requisite(s):	None
Course proposed by:	John Kerekes
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)

X	Semester Equivalent (SE) Please indicate which quarter course it is equivalent to: 1051-784 Pattern Recognition
	Semester Replacement (SR) Please indicate the quarter course(s) this course is replacing:
	New

2.2 Semester(s) offered (check)

Fall	Spring √	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, Electrical Engineering, or other Engineering programs.

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

Provide students with a firm understanding of the theory, techniques, and applications of pattern recognition.

4.0 Course description

IMGS-754 Pattern Recognition

This course develops a fundamental understanding of adaptive pattern recognition and a basic working knowledge of techniques for use in a broad range of applications. Inherent in adaptive pattern recognition is the ability of the system to learn by supervised or unsupervised training, or by competition within a changing environment. The effectiveness of the system depends upon its structure, adaptive properties, and specifics of the application. Particular structures developed and analyzed include Bayes decision theory, parametric and non-parametric techniques, multilayer perceptrons, and unsupervised clustering methods. The goal is to gain both a fundamental and working knowledge of each kind of technique and the ability to select the most appropriate one when faced with a real application design. (IMGS-613 or permission of instructor) **Class 3, Credit 3 (S, alternate years)**

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

5.1 Theodoridis and Koutroumbas, *Pattern Recognition*, Academic Press, Salt Lake City, UT

5.2 Bishop, *Pattern Recognition and Machine Learning*, Springer, New York, NY

5.3 Duda, P. Hart, and D. Stork, *Pattern Classification*, Wiley-Interscience, Hoboken, NJ

6.0 Topics (outline):

- 6.1 Introduction to Pattern Recognition
  - 6.1.1 Course overview
  - 6.1.2 Example applications
  - 6.1.3 Basic probability review
  - 6.1.4 Linear mathematics review
- 6.2 Bayesian Decision Theory
  - 6.2.1 Bayesian decision making
  - 6.2.2 Classifiers, discriminant functions, and decision surfaces
  - 6.2.3 Normal distribution
- 6.3 Parameter Estimation

- 6.3.1 Maximum Likelihood estimation
- 6.3.2 Maximum A Posteriori estimation
- 6.3.3 Bayesian estimation

6.4 Nonparametric Techniques
- 6.4.1 Density estimation
- 6.4.2 Parzen windows
- 6.4.3 k-nearest neighbor estimation
- 6.4.4 k-nearest neighbor classification

6.5 Linear Discriminant Functions
- 6.5.1 Linear discriminant functions and decision surfaces
- 6.5.2 Perceptron algorithm
- 6.5.3 Least squared error procedures
- 6.5.4 Support Vector Machines

6.6 Nonlinear Classifiers
- 6.6.1 Multilayer perceptrons (neural networks)
- 6.6.2 Backpropagation algorithm
- 6.6.3 Generalized linear classifiers
- 6.6.4 Decision Trees
- 6.6.5 Combining Classifiers

6.7 Feature Selection
- 6.7.1 Data preprocessing
- 6.7.2 Selection based on statistical hypothesis testing
- 6.7.3 Class separability measures
- 6.7.4 Optimal feature selection

6.8 Feature Transformation
- 6.8.1 Basis vectors
- 6.8.2 Karhunen-Loeve Transform
- 6.8.3 Independent Component Analysis
- 6.8.4 Shape features (moments, Fourier, fractals)

6.9 Template Matching
- 6.9.1 Correlation classifiers
- 6.9.2 Criterion functions

6.10 System Evaluation
- 6.10.1 Error counting
- 6.10.2 Error bounds

6.11 Unsupervised Clustering
- 6.11.1 Basic concepts
- 6.11.2 Distance metrics
- 6.11.3 Isodata algorithm
- 6.11.4 Special clustering topics

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

Course Learning Outcome	Homework	Exams
7.1 Identify various types of pattern recognition algorithms and when best to apply each technique	X	X
7.2 Apply parameter estimation to pattern recognition	X	X
7.3 Estimate accuracy, error probabilities, and error bounds	X	X

8.0 Program outcomes and/or goals supported by this course

8.1 To mathematically describe a wide range of pattern recognition techniques.
8.2 Demonstrates capabilities and limitations of pattern recognition techniques.
8.3 Prepares students with the education necessary to pursue careers in industry or to proceed to graduate research in imaging-related disciplines.

9.0

	General Education Learning Outcome Supported by the Course	**Assessment Method**
Communication		
	Express themselves effectively in common college-level written forms using standard American English	
	Revise and improve written and visual content	
	Express themselves effectively in presentations, either in spoken standard American English or sign language (American Sign Language or English-based Signing)	
	Comprehend information accessed through reading and discussion	
Intellectual Inquiry		
	Review, assess, and draw conclusions about hypotheses and theories	
	Analyze arguments, in relation to their premises, assumptions, contexts, and conclusions	
	Construct logical and reasonable arguments that include anticipation of counterarguments	
	Use relevant evidence gathered through accepted scholarly methods and properly acknowledge sources of information	
Ethical, Social and Global Awareness		
	Analyze similarities and differences in human experiences and consequent perspectives	
	Examine connections among the world's populations	
	Identify contemporary ethical questions and relevant stakeholder positions	
Scientific, Mathematical and Technological Literacy		
	Explain basic principles and concepts of one of the natural sciences	
	Apply methods of scientific inquiry and problem solving to contemporary issues	
	Comprehend and evaluate mathematical and statistical	

	information	
	Perform college-level mathematical operations on quantitative data	
	Describe the potential and the limitations of technology	
	Use appropriate technology to achieve desired outcomes	
Creativity, Innovation and Artistic Literacy		
	Demonstrate creative/innovative approaches to course-based assignments or projects	
	Interpret and evaluate artistic expression considering the cultural context in which it was created	

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

Smart classroom