Rochester Institute of Technology
Rochester, New York

College of Science
Chester F. Carlson Center for Imaging Science

Digital Image Processing: Spatial Pattern Recognition, 1051-784

1.0 Title: DIP: Spatial Pattern Recognition **Date:** October 20, 2006
Credit Hours: 4
Prerequisite(s): Graduate standing in a science or engineering program or permission of instructor. 1051-716, 718, 726, 0304-834 or equivalent.
Corequisite(s): none
Course described by: John Kerekes

2.0 Course information:

	Contact hours	**Maximum students/section**
Classroom	4	30
Lab		
Studio		
Other (specify _____)		

Quarter(s) offered (check)
_____**Fall** _____**Winter** __X___**Spring** _____**Summer**

Students required to take this course: (by program and year, as appropriate)
None.

Students who might elect to take this course:
Graduate students in Imaging Science, MS and PhD remote sensing track.
Graduate students in the College of Science or College of Engineering.

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 (as it will appear in the RIT Catalog, including pre- and co-requisites, quarters offered)

1051-784 Digital Image Processing: Spatial 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 effective- ness of the system depends upon it structure, adaptive properties and specifics of the application. Particular structures developed and analyzed include statistical PR, clustering systems, fuzzy clustering systems, multi-layered perceptrons (with a variety of weight training algorithms), and associative memory systems. The goal is to gain both a fundamental and working knowledge of each kind of system and the ability to make a good system selection when faced with a real application design. Also offered online. (1051-716, 718, 726, and 0304-834 or equivalent) **Class 4, Credit 4 (S)**

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

5.1 Duda, Richard, Peter Hart, and David Stork, *Pattern Classification*, Wiley-Interscience, 2001.
5.2 Instructor's Course Notes.

6.0 Topics

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
- 6.2.4 Error probabilities, integrals and bounds

6.3 Parameter Estimation
- 6.3.1 Maximum likelihood estimation
- 6.3.2 Bayesian estimation
- 6.3.3 Dimensionality
- 6.3.4 Component analysis
- 6.3.5 Fisher's linear discriminant and multiple discriminant analysis

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 Generalized linear discriminant functions
- 6.5.3 Gradient descent procedures
- 6.5.4 Perceptron criterion function
- 6.5.5 Minimum squared error procedures

6.6 Multilayer Neural Networks
- 6.6.1 Introduction and feedforward operation
- 6.6.2 Backpropagation algorithm
- 6.6.3 Error surfaces
- 6.6.4 Bayes theory

6.7 Stochastic Methods
- 6.7.1 Stochastic search
- 6.7.2 Boltzmann learning
- 6.7.3 Evolutionary methods (genetic algorithms and programming)

6.8 Nonmetric Methods
- 6.8.1 Decision Trees
- 6.8.2 Classification and Regression Trees (CART)
- 6.8.3 Grammatical methods

6.9 Unsupervised Learning
- 6.9.1 Clustering
- 6.9.2 Criterion functions

7.0 Intended learning outcomes and associated assessment methods of those outcomes

Learning Outcome	In class attendance and evaluation	Homework Assignments
7.1 Understanding of various types of pattern recognition algorithms and best when to apply each technique	X	X
7.2 Understanding parameter estimation applied to pattern recognition	X	X
7.3 Understanding of error probabilities, bounds and accuracy estimation	X	X

8.0 Program or general education goals supported by this course

8.1 Satisfies one element of elective course requirements for PhD in Imaging Science.

8.2 Prepares graduate students in science and engineering for careers in fields using pattern recognition techniques.

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

9.1 Classroom with computer projection system.

10.0 Supplemental information - NONE