

Nonlinear Optimization With Nonlinear Integrals
MATH 8530

1.0 Course Description

- 1.1 Overview of Content and Purpose:** (3 hours) The course is focused on using a new mathematical aggregation tool, the nonlinear integral, in nonlinear optimizations and on its applications in information fusion and data mining, where a soft computing technique (genetic algorithms and/or neural networks) is adopted to search numerical optimal solutions approximately. To provide students with both a theoretical and applied introduction to nonadditive set functions and relevant nonlinear integrals. This course will help students in mathematics, engineering and physics understand and apply certain nonlinear models in data analysis.
- 1.2 For Whom Intended:** Students in math, computer science, ISQA and engineering
- 1.3 Prerequisite:** Math 1960, Math 4740, prefer Math 4300 and CIST 1400 or equivalent.

2.0 Objectives:

- 2.1 Performance Objectives for the Student:** The student will be expected to become proficient in the following areas: nonadditive set functions and nonlinear integrals; applications of nonlinear integrals in information fusion and data mining using soft computing devices.

3.0 Content and Organization

- 3.1 Topics:**
1. Modeling on linear and nonlinear optimization problems
 2. Information fusion
 3. Nonadditive set functions (importance measures) and their apps.
 4. Nonlinear integrals as a new aggregation tool used in information fusion
 5. The inverse problem of information fusion
 6. Genetic algorithm used in optimizations
 7. Pseudo gradient search
 8. Nonlinear multiregressions
 9. Nonlinear classification

4.0 Teaching Methodology

- 4.1 Methods to Be Used:** This course will be presented by lecture, student presentation and class discussion.

5.0 Evaluation

- 5.1 Basis for Evaluating:** Evaluation will be based on student performance on homework assignments. There will be no quizzes but one test will be arranged. All students are required to complete a project on the theory of nonadditive

set functions or the applications of nonlinear optimization. All students are encouraged to complete a research paper, that can be submitted to some conference or journal, on nonadditive set functions or nonlinear optimization. Ph.D. students will be required to do a research paper.

6.0 Grading

6.1 Grade Scale: The grading will be determined by the instructor.

7.0 Resource Materials

7.1 Textbook(s): No textbook will be required. Handouts will be provided from the Book: *Generalized Fuzzy Theory*, Wang and Klir, Springer

7.2 Current Bibliography of Resources Adeli, *Machine Learning-Neural Networks, Genetic Algorithms, and Fuzzy Systems*, Wiley, 1995

Dennenburg, *Non-Additive Measure and Integral*, Kluwer, 1994

Han and Kamber, *Data-Mining-Concepts and Techniques*, Morgan Kaufman, 2000

Klir and Wang, *Generalized Measure Theory*, Springer, 2008

Pap, *Null-Additive Set Functions*, Kluwer, 1995

Wang, *Fuzzy Measure Theory*, Plenum Press, 1992