**Course Number:** CSc 876
**Course Title:** Soft Computing and Decision Support Systems
**Course Level:** Graduate/Senior undergraduate
**Number of Credits**: 3
**Schedule**: Three hours of lecture per week.
**Prerequisite**: CSc 810 or consent of instructor for students who completed CSc 510

**Catalog Description**

Survey of computational intelligence. Fuzzy sets, fuzzy logic, and fuzzy systems. Approximate reasoning. Possibility theory. Fuzzy decision making. Fuzzy controllers. Concept of rough sets. Computing with words, perceptual computing, and granular computing. Graded evaluation logic. Study of logic aggregation operators and information fusion models. Decision engineering methods. LSP method for evaluation and optimization of complex systems. Applications of soft computing. Development of software systems for decision support.

**Expanded Description**

The goal of this course is to present computing models and techniques that deal with imprecision, uncertainty, partial truth, and approximation, in a way that is similar to processing performed by human mind. Attempts to develop models that are similar to human reasoning resulted in important concepts of fuzzy sets, rough sets, fuzzy logic, possibility theory, preference logic, multicriteria decision models, and many applications based on neural networks, evolutionary computing, machine learning, probabilistic reasoning, etc. The goal of this course is to present selected areas of soft computing in an advanced research-oriented way, following current developments in this dynamic area. In particular, the course will include the following topics:

- **Fuzzy Sets and Fuzzy Logic**
  - Crisp sets and fuzzy sets
  - Alpha-cuts
  - Operations of fuzzy sets
  - t-norms and conorms
  - Fuzzy relations
  - Multivalued logics
  - Fuzzy propositions and quantifiers
  - Linguistic variables and their use
  - Inference in fuzzy systems
  - Information and uncertainty
  - Rough sets and their use

- **Applications of Fuzzy Logic**
  - Methods of using expert opinions
  - Fuzzy expert systems
  - Approximate reasoning
  - Design of fuzzy controllers

- Fuzzy decision making
- Fuzzy ranking methods
- Concepts of perceptual computing
- Concepts of granular computing

- **Graded Logic and Aggregation**
  - Partial Truth and Logic Conditions in Evaluation
  - Observable Properties of Human Evaluation Logic
  - Andness and Orness
  - Relative Importance and Weights
  - Graded Conjunction/Disjunction
  - Partial Absorption
  - Compound Preference Logic Functions
  - Nonstationary Criteria

- **LSP Method**
  - An Overview of the LSP Method
  - System Attribute Tree
  - Elementary Criteria
  - Logic Aggregation of Preferences
  - Cost/Preference Analysis
  - Reliability Analysis
  - Sensitivity Analysis
  - Tradeoff Analysis
  - System Optimization
  - LSP Software Technology

- **Multiple Criteria Decision Analysis**
  - Preference modeling
  - Utility theory
  - Value function methods
  - The Analytic Hierarchy Process
  - Outranking methods

- **Decision engineering: applications of MCDM methods**
  - Personal decision making
  - Medical decision making
  - Evaluation in ecology
  - Suitability maps
  - Evaluation of software systems
  - Software support for MCDM

**Method of Evaluation**

Student learning will be evaluated on the basis of completeness and quality of project assignments.

**Textbooks**

Klir, G.J. and B. Yuan, Fuzzy *Sets and Fuzzy Logic*. Prentice-Hall, 1995.
Ross, T.J. Fuzzy Logic With Engineering Applications. J. Wiley, 2010.
Dujmović, J., *Soft Computing Evaluation Logic*. In press. J. Wiley 2018.
Pedrycz, W., *Granular Computing.* CRC Press, 2013.
Mendel, J.M and D. Wu, *Perceptual Computing.* J. Wiley, 2010.

**Recommended Literature**

Kacprzyk, J. and W. Pedrycz, *Springer Handbook of Computational Intelligence*. Springer 2015.
S.N. Shahbazova (Ed.), Fuzzy Logic and its Applications. Selected Papers by Lotfi A. Zadeh. Little enterprise, 2016.
B. Kosko, *Fuzzy Thinking*. Hyperion, 1993.
J.M. Mendel, *Uncertain Rule-Based Fuzzy Logic Systems.* Prentice Hall, 2001.
V. Belton and T.J. Stewart, *Multiple Criteria Decision Analysis: an Integrated Approach*. Kluwer Academic Publishers (2002).
Zimmermann, H-J., *Fuzzy Set Theory and its Applications*. Kluwer Academic Publishers (1996).
C. Carlsson and R. Fullér, *Fuzzy Reasoning in Decision Making and Optimization*. Physica-Verlag (2002)
J. Fodor and M. Roubens, *Fuzzy Preference Modeling and Multicriteria Decision Support*. Kluwer Academic Publishers (1994).
C. Gini et al., *Means*. Italian original, *Le Medie*, Milano 1958.
R.L. Keeney and H. Raiffa, *Decisions with Multiple Objectives: Preferences and Value Tradeoffs*. John Wiley (1976).
P.S. Bullen, *Handbook of means and their inequalities*, Kluwer, 2003.

**Journals**

IEEE Transactions on Fuzzy Systems, IEEE Transactions on Syst., Man, Cybern., International Journal of Approximate Reasoning, Applied Soft Computing, Fuzzy Sets and Systems, International Journal of Uncertainty, Fuzziness, and Knowledge-Based Systems.

**Conferences**

FUZZ-IEEE, IPMU, IEEE WCCI, WCSC, EUSFLAT, AGOP, MDAI (Proceedings of these conferences contain the latest research results in this area)

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