COURSE OUTLINE
ENGR 520: Engineering Decision Support and Expert Systems

Credits: 3

Term(s) to be offered: Fall

Prerequisite: ENGR 510, Linear Programming and Network Flows; or equivalent

Catalog description: Optimization methods; linear programming, simplex algorithm, duality, sensitivity analysis, minimal cost network flows, transportation problem.

Instructor: John W. Labadie, Engr. B-211, Phone: (970)491-6898
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Text: Instructor Handouts

Reference Books: Turban, E. and J. Aronson, *Decision Support Systems and Intelligent Systems*, Prentice-Hall, 2005 [ISBN 0-13-089465-6]
Collette, Y. and P. Siarry, *Multiobjective Optimization: Principles and Case Studies*, Springer-Verlag, 2005 [ISBN 3-540-40182-2]
Tsoukalas, L. and R. Uhrig, *Fuzzy and Neural Approaches in Engineering*, John Wiley & Sons, 1997 [ISBN 0-471-16003-2]

Course Objectives: The student is introduced to development of decision support systems (DSS) for application to complex engineering management and design problems under conflicting objectives and uncertainty. A number of techniques are introduced for aiding in the analysis of a wide range of complex multiobjective engineering problems. Several stochastic optimization methods are presented for including risk and reliability in engineering design. Basic concepts of expert systems (ES) are discussed to show an essential synergy between DSS and ES for development of decision support structures that allow inclusion of human domain knowledge, heuristics and fuzzy logic. Heuristic methods such as genetic algorithms and particle swarm optimization are offered as a means of solving complex engineering design and management problems that defy traditional techniques of mathematical programming and operations research. Machine learning methods using artificial neural networks are introduced for solving complex dynamic scheduling and control problems in engineering. Each student is required to present a final class project involving application of the tools and concepts presented in the class to a real-world engineering decision problem.

Course Topics/Weekly Schedule:

Week	Topic
1.	Introduction to engineering decision support systems Normative vs. descriptive approaches in decision analysis
2.	Basic concepts in multiobjective analysis Multicriteria decision making; Nondominated solutions
3.	Discrete outranking methods; Weighted average method; PROMETHEE
4.	Discrete outranking methods; ELECTRE I and III; Applications

5. Analytical Hierarchy Process (AHP);
   Compromise programming; Applications
6. Methods for generating nondominated solutions;
   Stationarity conditions; Weighting method
7. Epsilon constraint method;
   Goal Programming; Applications
8. Introduction to stochastic multiobjective programming;
   2 stage stochastic programming with recourse; Risk analysis
9. Stochastic programming with probabilistic constraints;
   Chance constrained programming
10. Introduction to expert systems; Knowledge representation;
    Production rules
11. Inference mechanisms—backward and forward chaining;
    Presentation of expert system development tool
12. Uncertainty and fuzzy logic operators; Fuzzy rules and rule systems;
    Fuzzy multiobjective optimization; Applications
13. Introduction to genetic algorithms (GA);
    Selection, crossover, mutation, and replacement operations in GA
14. Applications of GA; multiobjective GA; Swarm intelligence methods;
    Particle swarm and Ant Colony
15. Introduction to neural networks; Backpropagation and radial basis ANN;
    Hopfield and recurrent networks; Applications to dynamic scheduling and control of engineering systems
16. Final student project presentations

Instructional Methodology: Two 75 min. lectures per week.

Mode of Delivery: Traditional lectures in class and via the course website for distance students.

Methods of Evaluation: The course grade will be based on the following distribution:

Homework	30%
Midterm Exam	30%
Final Class Project	40%
	100%