COURSE OUTLINE
ENGR 510: Engineering Optimization: Methods & Applications

Credits: 3

Term(s) to be offered: Fall Semester

Prerequisite: MATH 229 and MATH 261, or equivalent.

Course description: Optimization methods; linear programming, network flows, integer programming, interior point methods, quadratic programming, engineering applications.

Instructor: J. W. Labadie, B211 Engineering, Phone: (970) 491-6898

Textbook: *Linear and Nonlinear Optimization*, by I. Griva, S. Nash, and A. Sofer, 2nd Edition, Society for Industrial and Applied Mathematics, 2009. [ISBN: 978-0-898716-61-0]

Course Objectives: Introduce methods of optimization to engineering students, including linear programming, network flow algorithms, integer programming, interior point methods, quadratic programming, nonlinear programming, and heuristic methods. Numerous applications are presented in civil, environmental, electrical (control) engineering, and industrial engineering. The goal is to maintain a balance between theory, numerical computation, problem setup for solution by optimization software, and applications to engineering systems.

Upon successful completion of this course, the student will be able to understand:

(1) basic theoretical principles in optimization;
(2) formulation of optimization models;
(3) solution methods in optimization;
(4) methods of sensitivity analysis and post processing of results
(5) applications to a wide range of engineering problems

Course Topics/Weekly Schedule:

Week	**Topics**
1.	Introduction to methods of optimization; optimality and convexity
2.	General optimization algorithm; necessary and sufficient conditions for optimality
3.	Introduction to linear programming—a geometric perspective
4.	Standard form in linear programming; basic solutions; fundamental theorem of linear programming
5.	Simplex method; multiple solutions; tie-breaking procedures; two-phase method
6.	Duality theory in linear programming; complementary slackness; economic interpretation of the dual
7.	Sensitivity analysis; right-hand-side and cost ranging
9.	Applications: regression modeling in engineering; industrial blending problems; dynamic optimal control of engineering systems
10.	Applications (cont.): optimal estimation in environmental engineering; production planning in industrial engineering; transportation problem
11.	Minimum cost network flow algorithms; out-of-kilter method; primal-dual methods
12.	Integer programming; applications in optimal irrigation scheduling in agricultural engineering
13.	Interior point optimization methods; affine scaling method

14. Karush-Kuhn-Tucker conditions for constrained nonlinear programming problems; necessary and sufficient conditions; quadratic programming; applications
15. Heuristic optimization methods: genetic algorithms; ecological engineering application

Instructional Methodology: The class meets for two 75 minute lectures per week.

Mode of Delivery: Traditional lectures as well as nontraditional web-based instruction for distance students.

Methods of Evaluation: Weekly homework assignments, midterm examination, and final examination, with course grade based on the following distribution:

Homework	30%
Midterm Examination	30%
Final Examination	40%
Total	100%