Linear Programming
MATH 8430

1.0 Course Description

1.1 Overview of Content and Purpose: (3 hours) This course includes a complete development of theoretical and computational aspects of linear programming. Basic theoretical foundations covered include polyhedra, convexity, linear inequalities and duality. Advanced topics such as decomposition and column generation are covered. Both simplex methods and interior point methods are included.

1.2 For Whom Intended: Graduate students in math, computer science and engineering.

1.3 Prerequisite: Math 4300/8306

2.0 Objectives

2.1 Performance Objectives for the Student: Students will gain a thorough knowledge of the theoretical aspects of linear programming and understand the mathematical foundations of the simplex method. They will learn techniques such as decomposition and column generation for dealing with large-scale problems. They will understand computational aspects of linear programming as it relates to both simplex and interior point methods.

3.0 Content and Organization

3.1 Topics:

1. Introduction
    a. linear programming model
    b. applications
    c. geometric solution
2. Simultaneous Linear Equations
3. Convexity
4. Polyhedra
    a. polyhedral sets and cones
    b. extreme points, extreme directions
    c. representation of polyhedral sets
5. Simplex Method
    a. extreme points and optimality
    b. basic feasible solutions
    c. algebra of the simplex method
    d. optimality and unboundedness
    e. simplex method (tableaus)
    f. revised simplex method
    g. block pivoting
6. Starting Solution and Convergence
    a. initial basic feasible solution
    b. two-phase method

c. big-M method
d. degeneracy
e. cycling

7. Duality and Sensitivity
   a. formulation of the dual problem
   b. primal-dual relationships
   c. economic interpretation of the dual
   d. dual simplex
   e. primal-dual algorithm
   f. sensitivity analysis
8. Advanced Simplex Topics
   a. product form of the inverse
   b. decomposition
   c. column generation
9. Computational Complexity of Linear Programming
   a. worst-case behavior of the simplex method
   b. Ellipsoid method
   c. primal-dual interior point method

4.0 Teaching Methodology

4.1 Methods To Be Used: This course will be presented by lecture and class discussions.

5.0 Evaluation

5.1 Basis for Evaluating Evaluation will be based on student performance on homework assignments and exams.

6.0 Grading

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

7.0 Resource Materials

7.1 Textbook(s): Bazarraa and Sherali, *Linear Programming and Network Flows*, Wiley, 2004.

Nash and Sofer, *Linear and Nonlinear Programming*, McGraw Hill, 1996.

7.2 Current Bibliography of Resources:

1. Chvatal, *Linear Programming*, Freeman, 1983.
2. Gass, *Linear Programming: Methods and Applications*, 5th Ed., Dover 2003.
3. Luenberger, *Linear and Nonlinear Programming*, Addison-Wesley, 1984.
4. Solow, *Linear Programming: An Introduction to Finite Improvement Algorithms*, North-Holland, 1984.

5. Gass, *Linear Programming*, McGraw-Hill, 1985.
6. Hillier and Lieberman, *Introduction to Operations Research*, McGraw-Hill, 2004.
7. Jensen and Bard, *Operations Research: Models and Methods*, Wiley, 2003.
8. Taha, *Operations Research: An Introduction*, Prentice Hall, 03.
9. Vaserstein, *Introduction to Linear Programming*, Prentice Hall, 2003.
10. Winston, *Operations Research: Applications and Algorithms*, Thomson Brooks/Cole, 2004.