Prefix, Number and Name of Course: MAT 390 Introduction to Operations Research

Credit Hours: 3

In Class Instructional Hours: 3 **Labs:** 0 **Field Work:** 0

Catalog Description:

Prerequisites: MAT 202 and MAT 270

Optimization of real-world problems modeled by linear objective functions subject to systems of linear inequalities and solved by either the two-phase revised simplex method or by the network simplex method. Mathematics behind these methods. Applications in diverse areas such as business management, industry, economics, finance, game theory, geometry, and networks.

Reasons for Addition:

This course will introduce students to Operation Research concepts, which are needed for many applications of mathematics. Some technical details for adding this course are listed below.

1. To learn the concepts of operations research by way of modeling real-world problems as Linear Programming (LP) or Integer Linear Programming (ILP) problems.
2. To learn the geometry and mathematical analysis behind the theory of LPs and/or ILPs.
3. To learn the connections between LPs/ILPs and combinatorial optimization problems on discrete graph structures.
4. To be aware of the connections between operations research and other areas of mathematics.
5. To be aware of the variety of applications of operations research beyond the scope of academia.

Student Learning Outcomes:	Course Content References:	Assessment:
1. Students will formulate decision problems mathematically as LP or ILP problems.	I.	1. Group work in class, individual homework assignments, exams.
2. Students will learn the geometry and mathematics behind the LP and/or ILP simplex methods.	II, IV	2. Individual homework assignments, exams.
3. Students will solve LP and/or ILP problems by hand and (for larger problems) by use of technology.	II, IV	3. Group work in class, individual homework assignments, projects, exams.
4. Students will interpret the solutions to the primal and dual LP problems.	III	4. Individual homework assignments, projects, exams.
5. Students will learn the connection between LP/ILPs and combinatorial optimization problems on discrete graph structures.	V	5. Individual homework assignments, exams.
6. Students will apply operations research to diverse real-life fields as well as to other areas of mathematics.	VI	6. Group work in class, individual homework assignments, projects, exams.

Course Content:

I. Mathematical Modeling
   A. Formulations of real-world problems as Linear Programming (LP) and/or Integer Linear Programming (ILP) models
   B. Graphical solutions of some LP models

II. Linear Programming: The Simplex Method
   A. Ideas behind the simplex method
   B. The simplex algorithm for solving LP problems: primal and dual problems
   C. Interpreting optimal solutions: sensitivity analysis

III. Duality (optional)
   A. Corresponding dual problem to an LP problem
   B. Interpretation of the dual problem
   C. Relationship between the primal and dual problems
   D. Complementary slackness

IV. Integer Linear Programming
   A. Branch-and-bound algorithm
   B. Cutting plane algorithm

V. Analysis of LP and/or ILP complexity and of the efficiency of the methods

VI. Selected Applications
   A. Allocation of resources
   B. Scheduling production and inventory
   C. The cutting-stock problem
   D. Approximating data by linear functions
   E. Matrix games
   F. The transportation model
   G. The assignment and transshipment models
   H. Other miscellaneous applications

Resources:

Classic Scholarship in the Field:

Albers, D. J., and Reid, C. (1986). An interview with George B. Dantzig: The father of linear programming. *The College Mathematics Journal*, v. 17, no. 4.
Beck, E., and Kolman, B. (1980). Elementary Linear Programming with Applications. New York: Academic Press.
Bronson, R., and Naadimuthu (1997). Schaum's Outline of Operations Research. New York: McGraw-Hill.
Carter, M. W. (2000). Operations Research: A Practical Introduction. Boca Raton, FL: CRC Press.
Chvatal, V. (1983). Linear Programming. New York: W. H. Freeman and Co.
Dantzig, G. B. (1963). Linear Programming and Extensions. Princeton, NJ: Princeton University Press.
Marlow, W. H. (1993). Mathematics for Operations Research. New York: Dover Publications Inc.
Phillips, D. T., Ravindran, A. and Solberg, J. L. (1987). Operations Research: Principles and Practice, 2nd Edition. New York: Wiley & Sons
Rardin, R. L. (1997). Optimization in Operations Research. Englewood Cliffs, NJ: Prentice-Hall.
Simmons, D. M. (1972). Linear Programming for Operations Research. San Francisco: Holden-Day, Inc.
Wagner, H. M. (1975). Principles of Operations Research with Applications to Managerial Decisions, 2nd Edition. Englewood Cliffs, NJ: Prentice-Hall.

Current Scholarship in the Field:

Bard, J. F. and Jenson, P. A. (2002). Operations Research Models and Methods. New York: John Wiley and Sons.
Heyman, D. P. and Sobel, M. J. (2004). Stochastic Models in Operations Research, Vol. I: Stochastic Processes and Operating Characteristics. Mineola, NY: Dover Publications, Inc.
Hillier, F. S. and Lieberman, G. J. (2002). Introduction to Operations Research. Oakland, Calif.: Holden-Day, Inc.
Kimball, G. E. and Morse, P. M. (2003). Methods of Operations Research. Mineola, NY: Dover Publications, Inc.
Ray, S. C. (2004). Data Envelopment Analysis: Theory and Techniques for Economics and Operations Research. New York: Cambridge University Press.
Taha, H. A. (2002). Operations Research: An Introduction, 7th Edition. New York: Macmillan Co.
Winston, W. L. (2003). Operations Research: Applications and Algorithms. Boston: Duxbury Press

Periodicals:

College Mathematics Journal
The American Mathematical Monthly
Mathematics Magazine
The Journal of Undergraduate Mathematics and Its Applications (COMAP)

Electronic and/or Audiovisual Resources:

Journal of the Operations Research Society of America, JSTOR
(http://www.jstor.org/)

Operations Research Letters, Elsevier
(http://www.sciencedirect.com/science/Journal/01676377)