# Operations Research Models

## ME 366L (#19460) / ORI 366 (#19905)

## Fall Semester 2021

**Classroom:** ETC 4.150

**Meeting Time:** 12:30-2pm on Tuesdays and Thursdays

**Prerequisites:** Multivariable Calculus (M 408D or equivalent)


**Instructor:** Yutong Wu

**Office:** ETC 5.128A

**Office Hours:** 10-11:45am & 2-4pm on Tuesdays and Thursdays, or by appointment

**E-mail:** yutong.wu@utexas.edu


**Text:** P.A. Jensen and J.F. Bard, *Operations Research Models and Methods*, John Wiley & Sons Inc., New York, 2003.

**Software:** Gurobi: `https://www.gurobi.com/`
or ORMM Add-ins for Microsoft Excel: `https://utw11041.utweb.utexas.edu/ORMM/`
or CVXPY: `https://www.cvxpy.org/`

## Grading Policy

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|---|---|---|
| Problem Sets | | 30% |
| Midterm 1 | Tuesday, Oct 5, in class | 20% |
| Midterm 2 | Thursday, Nov 18, in class | 20% |
| Final | Saturday, Dec 11, 7-10pm | 30% |

• Problems sets are due at the *beginning* of class on specified days; late problem sets will be penalized 20%. There are 6 problem sets in total, and the lowest score will be dropped.
• You are encouraged to work together in determining how to do the problem sets, but problem sets must be written-up individually.
• The midterm exams and final are closed book and closed notes.

**Syllabus:** This course provides an introduction to the most important types of mathematical models used in operations research, including linear programming, network optimization, integer programming, nonlinear programming, discrete- and continuous-time Markov chains, queueing theory and decision analysis. The emphasis of the course is on building appropriate mathematical models, solving these models via commercial software, analyzing solutions, performing sensitivity analyses, and testing model validity. The course includes applications and models in a variety of areas including manufacturing and production, employee scheduling, system capacity expansion, blending problems, distribution models, financial arbitrage, network reliability, facility location, airline crew scheduling, portfolio selection, and equipment maintenance.

## Course Outline

- Introduction
  - operations research overview
  - mathematical programming
  - stochastic modeling

- Linear Programming
  - LP assumptions
  - computational considerations
  - solution properties
  - sensitivity analysis
  - formulation techniques & example formulations

- Network Optimization
  - minimum cost flow problems
  - generalized networks
  - models with multiple time periods
  - formulation techniques & example formulations

- Integer Programming
  - logical constraints
  - fixed charges
  - facility location model
  - covering models

- Nonlinear Programming
  - convexity of sets and functions
  - example formulations

- Probability Models
  - events and random variables
  - conditional probability

exponential distribution
Poisson distribution

- Discrete-Time Markov Chains
  stochastic processes
  $n$-step transition probabilities
  classification of states
  steady-state calculations
  first passage times
  absorption probabilities
  examples

- Queueing
  basic structures
  Little's law
  continuous-time Markov chains
  birth-and-death processes
  balance equations
  examples

- Decision Analysis
  utility functions
  Bayes' rule
  experimentation
  decision trees

- Selected Topics in Game Theory
  Nash equilibrium
  routing games
  auction design

## References

F.S. Hillier and G.J. Lieberman, *Introduction to Operations Research*, Eighth Edition, McGraw-Hill, New York, NY, 2005.

W.L. Winston, *Operations Research: Applications and Algorithms*, Third Edition, Wadsworth Publishing Company, Belmont, CA, 1997.

S.P. Bradley, A.C. Hax, and T.L. Magnanti, *Applied Mathematical Programming*, Addison-Wesley, Reading, MA, 1977. Available for free download: `http://web.mit.edu/15.053/www/`

H.M. Taylor and S. Karlin, *An Introduction to Stochastic Modeling*, Third Edition, Academic Press, San Diego, CA, 1998.

## Additional Administrative Notes

**Disability Statement**: Students with disabilities who require special accommodations need to get a letter that documents the disability from the Services for Students with Disabilities area of the Office of the Dean of Students. This letter should be presented to the instructor in each course at the beginning of the semester and accommodations needed should be discussed at that time. Five business days before an exam the student should remind the instructor of any testing accommodations that will be needed. See the website below for more information: https://diversity.utexas.edu/disability/

**Academic Integrity**: Students who violate University rules on scholastic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course and dismissal from the University. Since dishonesty harms the individual, fellow students, and the integrity of the University, policies on scholastic dishonesty will be strictly enforced. I expect everyone to follow the UT Honor Code, which states: "The core values of The University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the university is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community."

**Course Evaluation**: If you have comments or suggestions on the course as we go through it, please let me know by coming to office hours or making an appointment. Near the end of the course, you will also have an opportunity to anonymously evaluate the course and instructor using the standard College of Engineering evaluation form.