IEOR 251
Facilities Design and Logistics
Spring 2005

Instructor:
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Office Hours:
Monday 2:00-3:00
Tuesday 11:00-12:00
or by appointment.

Course Meetings:
Monday 12:00-1:30 1174 Etcheverry Hall
Wednesday 12:00-1:30 1174 Etcheverry Hall

Course Description:
This is an advanced course focusing on mathematically rigorous analysis of models and algorithms for the analysis and control of manufacturing and logistics systems. In particular, we will focus on understanding why, how, and how well algorithms for these problems work. Often, we will do this by first focusing on simplified versions of the problems, and then by considering progressively more complex versions. Many of the papers and topics we cover will be quite theoretical, and many of the models we consider will be vastly simplified versions of real systems. We will begin by exploring analytical techniques such as worst-case and average case analysis, and then consider the application of these techniques to routing, inventory, scheduling, and integrated distribution models and algorithms.

By the end of the course, you should understand how algorithms can be developed to take advantage of the structure of models. Also, you should be able to apply the approaches and techniques we have discussed to problems we have not specifically considered in class.

Text:
The main text for this course is:

The Logic of Logistics, Second Edition by Simchi-Levi, Chen, and Bramel,(2005: Springer)

The scheduling material will come primarily from:

Scheduling: Theory, Algorithms, and Systems, Second Edition by Pinedo (2002: Pren-

tice Hall)

The following books, on reserve in the engineering library, may also be helpful:

Analysis of Inventory Systems by Hadley and Whiten (1963: Prentice-Hall)

Production and Inventory Management by Hax and Candea (1984: Prentice-Hall)

Logistics of Production and Inventory edited by Graves, Rinnooy Kan, and Zipkin (1993: Elsevier)

Quantitative Models for Supply Chain Management edited by Tayur, Ganeshan, and Magazine, (1999: Kluwer Academic Publishers)

Supply Chain Management: Design, Coordination and Operation edited by de Kok and Graves, (2004): Kluwer Academic Publishers)

Logistics of Production and Inventory edited by Graves, Rinnooy Kan, and Zipkin (1993: Elsevier)

Network and Discrete Location by Daskin (1995: Wiley)

In addition, some of the coverage of certain topics in the text will be augmented by research papers. A tentative list of these papers is included in the list of topics at the end of this syllabus.

Lecture Notes

Each class member will be responsible for taking notes in several classes (depending on class size), and sending those notes to me in electronic form. I will review, edit, and distribute the notes as soon as possible. The quality of your lecture notes will be one of the factors in your final grade.

Assignments and Grading

There will be four to six homework assignments.

There will also be a **midterm**, fairly late in the semester, and a **course project and presentation**.

The project will consist of a research proposal; you will be responsible for selecting an interesting problem, modeling the problem in a useful way, finding applicable prior research in the literature, and perhaps obtaining some preliminary results. The last few classes will be devoted to oral presentations of each project.

Please don't wait until the last minute to begin work on the project. Also, be sure to discuss project ideas with me before starting to work.

Course Topics

We will cover many of the topics contained in the textbook in roughly the same order, augmenting the text with appropriate papers. This is a new course, so the syllabus is tentative,

and subject to change. Also, let me know if there are other topics which you would like to cover.

- Worst-Case Analysis
  - The Bin-Packing Problem
  - The Travelling Salesman Problem
- Average Case Analysis
  - The Bin-Packing Problem
  - The Travelling Salesman Problem
- Performance Bounds based on Mathematical Programming
  - The Bin-Packing Problem
  - The Travelling Salesman Problem
- Convexity and Supermodularity
- Inventory Models
  - A Review of Deterministic Models
  - Stochastic Inventory Models
    Clark, A.J. and H. Scarf (1960) Optimal Policies for a Multi-Echelon Inventory Problem. *Management Science* **6**, 475-490.

    Federgruen, A, and P. Zipkin (1984) Approximation of Dynamic, Multi-Location Production and Inventory Problems. *Management Science* **30** pp. 69-84.

    Federgruen, A, and P. Zipkin (1984) Computational Issues in and Infinite-Horizon, Multi-Echelon Inventory Model. *Operations Research* **32** pp. 818-836.

    Bourakiz, M. and M. J. Sobel (1992) Inventory Control with an Exponential Utility Criterion. *Operations Research*, **40**, pp. 603-608.

    Kapuscinski, R. and Tayur, S. (1998). A capacitated production-inventory model with periodic demand. *Operations Research* **46** pp. 899-911.
  - Integrated Pricing and Inventory Models
    Gallego, G., and G. Van Ryzin (1994) Optimal Dynamic Pricing of Inventory with Stochastic Demand Over Finite Horizons. *Management Science* **40** pp. 999-1020.

    Federgruen, A. and A. Heching (1999) Combined Pricing and Inventory Control Under Uncertainty. *Operations Research* **47**, pp. 454-475.

    Federgruen, A. and A. Heching (2002) Multi-location Combined Pricing and Inventory Control. *Manufacturing and Service Operations Management* **4**, pp. 275-295.
- Vehicle Routing Models
  - Capacitated VRP with Equal Demands

- Capacitated VRP with Unequal Demands
  Fisher, M., and R. Jaikumar. (1981) A Generalized Assignment Heuristic for Vehicle Routing. *Networks* **11**, pp. 109-124.

  Christofides, N., A. Mingozzi, and P. Toth. (1981) State-Space Relaxation Procedures for the Computation of Bounds to Routing Problems. *Networks* **11**, pp. 145-164.
- VRP with Time Window Constraints
  Solomon, M. (1986) On the Worst-Case Performance of Some Heuristics for the Vehicle Routing and Scheduling Problem with Time Window Constraints. *Networks* **16**, pp. 161-174.
- Column Generation for the VRP
  Cullen, F., J. Jarvis, and D. Ratliff. (1981) Set Partioning Based Heuristics for Interactive Routing. *Networks* **11**, pp. 125-143.
- Stochastic VRP
  Jaillet, P. (1988) A Priori Solution of a Traveling Salesman Problem in Which A Random Subset of the Customers are Visited. *Operations Research* **36**, pp. 929-936.

  Bertsimas, D., P. Jaillet, and A. Odoni (1990) A Priori Optimization. **Operations Research 38**, pp. 1019-1033.

  Bertsimas, D. (1992) A Vehicle Routing Problem with Stochastic Demand. *Operations Research* **40** pp. 574-585.
- Vehicle Dispatching and Allocation
  Farvolden, J., and W. Powell. (1994) Subgradient Methods for the Service Nework Design Problem. *Transportation Science* **28**, pp. 256-272

- Supply Chain Planning and Integrated Logistics

  Pirkul, H. and V. Jayaraman. (1996) Production, Transportation, and Distribution Planning in a Multi-Commodity Tri-Echelon System. *Transportation Science* **30**, pp. 291-301.

  Geoffrion, A .M. (1972) Generalized Benders Decomposition. *Journal of Optimization Theory and Applications* **10** pp. 237-260.

  Geoffrion, A.M. and G. Graves (1974) Multicommodity Distribution System Design by Benders Decomposition. *Management Science* **20** pp. 822-844.

  Anily, S., and A. Federgruen (1990) One Warehouse Multiple Retailer Systems with Vehicle Routing Costs. *Management Science* **36**, pp 92-114.

  Dror, M., and M. Ball. (1987) Inventory/Routing: Reduction from an Annual to a Short-Lived Problem. *Naval Research Logistics* **34** pp. 891-905.

  Graves, S. and S. Willems (2000). Optimizing Strategic Safety Stock Placement in Supply Chains.*Manufacturing and Service Operations Management* **2**, pp. 68-83.

- Production Scheduling Models

Adams, J., E. Balas and D. Zawack (1988). The Shifting Bottleneck Procedure for Job Shop Scheduling. *Management Science* **34**, 391-401.

Hoogeveen, J.A. and A.P.A. Vestgens. (1996) Optimal on-Line Algorithms for Single Machine Scheduling. *Proceedings of the Fifth Conference on Integer Programming and Combinatorial Optimization* pp.404-414.

Kaminsky, P. and D. Simchi-Levi. (2001). The Asymptotic Optimality of the Shortest Processing Time Rule for the Flow Shop Completion Time Problem. Operations Research **49**, p. 293-304