

Math 5711 – Linear and combinatorial  
optimization – Spring 2001  
Rough Schedule

Mark de Longueville

**Text book used:** Vašek Chvátal, Linear Programming, W. H. Freeman and Company, 1983

**Introduction (3 classes)**

- logistics in pacific war
- transportation problems
- nutrition problems
- network flow problems
- algorithms and their power
- theory involved
- first example – the graphic method
- more interesting example: oil refinery à la Padberg, CPLEX output etc.
- Berlin airlift
- small refinery example à la Groetschel more detailed
  - graphic solution
  - discuss optimality
  - complexity of the problem
  - first algorithmic ideas
  - upper bounds – first idea of duality theory
  - dual program
  - economic interpretation – shadow prices
- Homework #1: Problems 1.1 to 1.5 in Chvátal's book

### **The simplex method – Chvátal Chapters 2 and 3 (7 classes)**

- simplex algorithm
- initialization, iteration, termination
- discuss pivot rules
- proof perturbation avoids cycling
- Homework #2: Problems 2.1,2.2,3.1,3.3,3.7,3.9 in Chvátal's book

### **On complexity – Chvátal Chapter 4 (1 class)**

- The Klee-Minty cube
- Homework #3: Problems 3.9,4.1 in Chvátal's book

### **First Midterm (1 class)**

### **Duality theory – Chvátal Chapter 5 (6 classes)**

- duality theorem
- complementary slackness
- economic interpretation
- examples
- Homework #4: Problems 5.1,5.2,5.3 in Chvátal's book
- Homework #5: Problems 1.6, 5.4 in Chvátal's book

### **The revised simplex method – Chvátal Chapter 7 (4 classes)**

- revised simplex method
- economic interpretation
- proof of Theorems 5.4 and 5.5 (Problems 7.3 and 7.4) in Chvátal's book
- Homework #6: Problem 7.1 in Chvátal's book

## **Geometry – various sources (8 classes)**

- polyhedra
- relation: polyhedra – LP problems
- some linear algebra: affine spaces etc. (Farkas lemmas and alike is not doable with the prerequisites required.)
- geometry of the simplex algorithm (almost like in Chvátal Chapter 17)
- geometric meaning of duality (as in Schrijver's book)
- examples
- rediscuss degeneracy and perturbation (as in Chvátal Chapter 17)
- Homework #7: sheet on affine spaces, polyhedra, relation polyhedra – LP in dimension 3

## **Second Midterm (1 class)**

### **Applications – Chvátal Chapters 11, 12 and 13 (5 classes)**

- Case study in forestry (simplified) – Chapter 11
- Scheduling production and inventory (with transparencies) – Chapter 12
- discuss integrality problem
- the cutting stock problem – Chapter 13
- the Knapsack problem
- branch and bound
- Homework #8: Problems 13.2 a), 13.4, 13.5 in Chvátal's book

### **The network simplex method – Chvátal Chapter 19 (5 classes)**

- networks
- some graph theory: trees, spanning trees, etc.
- network simplex method
- initialization, iteration, termination
- Homework #9: Problems 19.1, 19.4, 19.6, 19.10 in Chvátal's book

### **Review of the semester, practice exam (3 classes)**