

## 34414 - FX - Network Flows

Coordinating unit: 200 - FME - Faculty of Mathematics and Statistics  
Teaching unit: 715 - EIO - Department of Statistics and Operations Research  
Academic year: 2011  
Degree: MASTER IN STATISTICS AND OPERATIONS RESEARCH (Syllabus 2006). (Teaching unit Optative)  
DOCTORATE IN STATISTICS AND OPERATIONAL RESEARCH (Syllabus 2007). (Teaching unit Optative)  
ECTS credits: 5 Teaching languages: Catalan

### Teaching staff

Coordinator: FRANCISCO JAVIER HEREDIA CERVERA  
Others: FRANCISCO JAVIER HEREDIA CERVERA - A

### Prior skills

Operations Research. Continuous optimization. Large-scale optimisation. Modelling in mathematical programing

### Teaching methodology

The teaching method will combine traditional expository sessions regarding theory and laboratory sessions/extra support problems/extra sessions on theory. The teaching method will require specified learning materials for following the subject and for completion of the work sessions.

### Learning objectives of the subject

This is an advanced course on model building and the optimization of network flow problems. Its goals are:

- \* That the student will know which are the principal problems of network flows (shortiest path, maximum flow, minimum cost, etc.) and its relevance to the environment of decision-making models.
- \* That the student knows how to formulate and solve  $\zeta$ through computation $\zeta$ decision-making problems such as network flows of different types.
- \* That the student knows which are the principal algorithms that permit the solution of network flow problems, their theoretical properties and implementation characteristics.

### Content

#### Introduction

Description:  
Network Flow Problems and Their Applications. Basic Concepts of Graph Theory. Basic Design Concepts and Algorithm Analysis.

## 34414 - FX - Network Flows

### Shortest Path Problems.

Description:

Definition and the Model-Building Hypothesis. Applications. Aplicaciones. Implementations of Dijkstra's Generic Label-Setting Algorithm: Inverse, Dial, Heap, etc. Label-Correcting Algorithms: Implementation, Pseudo-Polynomials and Polynomials. All Pairs Shortest Path Problems: Dantzig's and Floyd-Warshall's Algorithms.

### Maximum Flow Problems.

Description:

Definition and the Model-Building Hypothesis. Applications. Augmenting Path Algorithms: Ford-Fulkerson. Max-Flow Min-Cut Theorem. Preflow-Push Polynomial Algorithms: FIFO and Scaling Algorithms.

### Minimum Cost Flow Problems.

Description:

Definition and the Model-Building Hypothesis. Applications. Basic Algorithms: Cycle Canceling, Successive Shortest Paths, Out-Of-Kilter. Polynomial Algorithms: Capacity Scale Algorithm. Simplex Algorithm for Minimum Cost Flow. The Frank-Wolfe Algorithm.

### Minimum Spanning Trees.

Description:

Application Examples. Kruskal Algorithm. Prim Algorithm. Sollin Algorithm.

### Multi-Item Problems.

Description:

Definition and the Model-Building Hypothesis. Applications. Optimal Conditions. Lagrangian Relaxation. Application of the Dantzig Decomposition. Primal Partitioning.

### Nonlinear Flow Problems.

Description:

Definition and the Model-Building Hypothesis. Nonlinear Flow with Convex Costs. Nonlinear Flow, Whatever the Cost: Murtagh-Saunders's Specialized Algorithm.

## 34414 - FX - Network Flows

### Generalized Flow Problems.

Description:

Definition and the Model-Building Hypothesis. Applications. Augmented Forests and Optimal Conditions. Simplex Algorithm for Generalized Flows.

### Qualification system

A partial exam and a final exam.

The final note will comprise 60% theory and 40% class work.

### Bibliography

#### Basic:

Ahuja, R. K.; Magnanti, T.L.; Orlin, J.B. *Network flows: theory, algorithms, and applications*. Englewood Cliffs, N.J.: Prentice Hall, 1993. ISBN 013617549X.

Bertsekas, Dimitri P. *Network optimization: continuous and discrete models*. Belmont, MA: Athenea Scientific, 1998. ISBN 1886529027.

Fourer, R.; Gay, D.M.; Kernighan, B.W. *AMPL: a modeling language for mathematical programming*. 2nd ed. Pacific Grove, CA: Thomson/Brooks/Cole, 2003. ISBN 0534388094.

Taha, Hamdy A. *Operations research: an introduction*. New Jersey: Prentice Hall International, 2007. ISBN 0131889230.

Kennington J.L.; Helgason R.V. *Algorithms for Network Programming*. New York: John Wiley & Sons, 1980. ISBN 047106016X.

#### Others resources:

##### Hyperlink

<http://www.ise.ufl.edu/ANO/>

[http://web.mit.edu/jorlin/www/15.082/15082\\_syllabus\\_2003.html](http://web.mit.edu/jorlin/www/15.082/15082_syllabus_2003.html)

<http://www-b2.is.tokushima-u.ac.jp/~ikedada/suuri/main/index.shtml>