COMBINATORIAL OPTIMIZATION

- **Course code**

  8116

- **Type of course (compulsory, optional)**

  Elective (compulsory for the stream "Operations Research and Management Science")

- **Level of course** (e.g. first, second or third cycle; sub-level if applicable)

  N/A

- **Year of study**

  2013-2014

- **Semester**

  7th semester

- **Number of credits allocated**

  6 ECTS Credits

- **Name of lecturer**

  Ioannis Mourtos, Assistant Professor

- **Learning outcomes**

  The course deals with the theory, algorithms and applications of discrete (also known as combinatorial) optimization with an emphasis on problems regarding flows, paths and matchings on graphs. More specifically, the course presents algorithms for the problems of shortest path, maximum flow, minimum-cost flow, maximum-cardinality and maximum-weight matchings (mostly regarding bipartite graphs) and, last, stable matchings and b-matchings on bipartite graphs.

  Apart from solving such problems using specialized combinatorial algorithms, the students are also expected to formulate applications and real-life problems as flow, path or matching problems on graphs. In addition, this course introduces general methods for discrete optimization problems that can be modeled as Linear Integer Programs, i.e., Branch-and-Bound and Branch-and-Cut.

  The purpose of this course is the understanding of algorithmic design specifically for discrete optimization algorithms defined on graphs and integer programming methods. Apart from understanding all related notions, the purpose is to investigate the application of such algorithms (i.e., algorithms for paths, flows and matchings) on real-life problems.

- **Mode of delivery (face-to-face, distance learning)**

  Face-to face teaching in the form of lectures and classes, case study discussion

- **Prerequisites and co-requisites**

  N.A.

- **Recommended optional programme components**

  N.A.

- **Course contents**

  The course material includes the following topics:

  - Network Flows and Integer Programming
  - Shortest-path algorithms: Dijkstra, Bellman-Ford, Floyd-Warshall
  - Maximum-flow and minimum-cost flow algorithms

- Matching algorithms in bipartite graphs: maximum-cardinality matching, maximum-weight matching, stable matching and stable b-matching
- Applications modeled as flow problems: project management, job assignment to machines, distinct and restricted representatives, capital allocation, etc.
- Integer Programming: Branch-and-bound methods, Balas' additive algorithm, Branch-and-Cut methods
- Applications of Integer Programming
- Trees: properties, transversal algorithms, minimum-spanning tree algorithms, Steiner trees..

- **Recommended or required reading**

  📖 P. Miliotis, I. Mourtos Discrete Optimization (in Greek), AUEB press.

  Further textbooks that are recommended and available at the library:

  📖 Integer and combinatorial optimization, Wolsey , Laurence A., Nemhauser , George L., New York : Wiley 1988

  📖 Combinatorial optimization : networks and matroids, Lawler , Eugene L., New York : Holt,

  📖 Surveys in combinatorial optimization, Martello , Silvano, Amsterdam : North-Holland 1987

  📖 Geometric algorithms and combinatorial optimization, Grotschel , Martin, Lovasz , Laszlo, Schrijver , Alexander, Berlin : Springer 1988

  📖 Combinatorial optimization : algorithms and complexity, Papadimitriou Christos., Steiglitz , Kenneth Englewood Cliffs, N.J. : Prentice-Hall 1982

  Additional notes, exercise and teaching material are available on the Department's educational portal (Eduportal)

- **Planned learning activities and teaching methods**

  N.A.

- **Assessment methods assessment methods and criteria**

  Assessment is determined by the final written examination and a non-compulsory assignment, which asks for the encoding of specific algorithms in Java.

- **Language of instruction**

  Greek

- **Work placement(s)**

  N.A.