

## Graph Theory and Applications

**Niveau :** Master, 1<sup>st</sup> year (M1)

**Cursus :** Master Economics, Data and Decision Science

**Semestre :** 1st semester

**Volume horaire :** 33 h (CM)

**Intervenant :** Stéphane GONZALEZ and Federica CERON

**Contact :** [stephane.gonzalez@univ-st-etienne.fr](mailto:stephane.gonzalez@univ-st-etienne.fr) and [federica.ceron@univ-st-etienne.fr](mailto:federica.ceron@univ-st-etienne.fr)

**Objectifs du cours :**

**Plan de cours :**

The course is split in 2 equal parts.

- Stéphane GONZALEZ will discuss the main concepts and definitions of graph theory and show how these tools can be used to model a wide range of problems. Building on these foundations, this part of the course presents several applications of graph theory in economics, operations research, and the social sciences: centrality indices in social networks, the resolution of allocation, routing, matching and assignment problems, combinatorial games on graphs, scheduling and precedence constraints, and diffusion models on networks. The course will also include a brief introduction to Markov chains, as well as to the growth model of Hamilton (1989) and its connections with discrete structures. On the theoretical side, we will prove a number of fundamental mathematical results—such as Sperner’s Lemma, Euler’s Theorem, and key notions from algebraic graph theory—and explain why these results are useful in many applied frameworks.
- Federica CERON will cover the following topics: Trees, Minimum-Cost Spanning Trees, Depth-First Search, the Shortest Path Problem, Euler Tours, and Hamiltonian Cycles. Each topic will include a theoretical presentation of the core algorithms as well as a discussion of their principal applications.

**Compétences développées :**

Students learn to understand, analyze, and apply fundamental graph algorithms; to evaluate their correctness and efficiency; and to recognize how these methods are used to model and solve real-world problems. By the end of the course, students will be able to model problems using graph structures, understand the main reasoning techniques of discrete mathematics, and master several general concepts that underpin numerous applications in data science, economics, and decision-making.

**Modalités d’évaluation :**

The final grade will be determined as the average grade in two written examinations, a midterm and a final term at the end of the course. A bonus may be awarded to students who actively participate in class.



**Prérequis :**

A basic understanding of logical and mathematical reasoning is required.

**Bibliographie / références :**

- *Graph theory with applications* by Bondy, John Adrian and Murty, Uppaluri Siva Ramachandra, London: Macmillan, 1976.
- *Graph Theory* by Diestel, Reinhard. Springer-Verlag New York, 2000.