

## Content

| Course Code | Course Name   | Semester | Theory | Practice | Lab | Credit | ECTS |
|-------------|---------------|----------|--------|----------|-----|--------|------|
| MAT353      | Combinatorics | 5        | 3      | 0        | 0   | 3      | 5    |

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|------------------------|--|
| Prerequisites          |  |
| Admission Requirements |  |

|                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
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| Language of Instruction | French                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Course Type             | Elective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Course Level            | Bachelor Degree                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Objective               | This course presents the fundamental principles, structures, and techniques of enumerative and structural combinatorics. It covers bijective reasoning, generating functions, partially ordered sets, graphs and trees, Catalan structures, permutations, partitions, Young tableaux, and classical combinatorial correspondences. The course also aims to develop students' ability to construct rigorous combinatorial arguments and to identify common structures in seemingly disparate counting problems.                                                                                                                                                     |
| Content                 | This course offers an introduction to combinatorics through the study of finite sets and finite functions, counting principles, generating functions, relations and graphs, partially ordered sets and lattices, trees, permutations, partitions, and arrays. Classical enumerative families, such as Catalan configurations, binary trees, polygonal triangulations, and integer partitions, are studied along with the bijections that connect them. The course concludes with the study of Young tableaux and the Robinson-Schensted-Knuth correspondence, illustrating the interaction between enumeration, algebraic structure, and combinatorial algorithms. |
| References              | Introduction à la combinatoire<br>Notes de cours<br>Professeur : François Bergeron                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

## Theory Topics

| Week | Weekly Contents                                                                                                     |
|------|---------------------------------------------------------------------------------------------------------------------|
| 1    | Recall on sets, functions, and bijections                                                                           |
| 2    | Cardinalities of sets, the pigeonhole principle, the inclusion-exclusion principle, sequences and generating series |
| 3    | Relations, graphs, isomorphisms, equivalences, partitions                                                           |
| 4    | Orders, lattices, paths in a directed graph                                                                         |
| 5    | Trees, endofunctions                                                                                                |
| 6    | Binary trees, triangulations of a polygon                                                                           |
| 7    | Exam                                                                                                                |
| 8    | Solutions of the exam                                                                                               |
| 9    | Catalan configurations and bijections                                                                               |
| 10   | Permutations, inversions, partitions                                                                                |
| 11   | Ferres diagrams, Euler's pentagonal theorem                                                                         |
| 12   | Young tableaux, Robinson-Schensted-Knuth correspondence                                                             |
| 13   | Student presentations                                                                                               |
| 14   | Student presentations                                                                                               |