Theoretical questions (Part 1 of the Oral Exam)

You should prepare the following topics. In the oral exam you will have the possibility to choose one from two proposed topics. Recall that you should know **all** the material from the lectures, because the examiners will ask you questions during the oral exam.

After you choose one of the topics, you will have 30 minutes before the oral exam to prepare/center yourself on the topic you have choosen in order to start explaining some details. You can prepare all of this **WITHOUT** material.

You should also prepared for questions. Also, you do not have to work by yourself on the proofs/computations that have not been done in the lectures (the proof of the Transfer Theorem, ...). This is something that the examiners won't ask you.

The topics are deliberately vague: you have the freedom to develop your topic as you want, and possibly not covering it fully. The goal is to show that have understood the part you want to develop, and that you are able to answer the questions of the examiners.

The whole oral exam will be done in Arnimallee 3, office 204. The 30-min preparation will be done in a office near this one.

The list of topics for the theoretical part are the following:

1. Formal power series, and operations that can be defined over them.
2. Rational, Algebraic and D-finite formal power series. Definitions, relations with sequences and hierarchy.
3. Laurent series, residues and Lagrange inversion formula.
4. What is a combinatorial class, an admissible combinatorial class and related generating functions. Operations that can be defined over a combinatorial class.
5. The Hamadard product: properties.
6. Labelled combinatorial classes: the labelled product and exponential generating functions. Further operations.
7. Multivariate generating functions and discrete probability distributions. Computations.
8. The boxed product of labelled combinatorial classes.
9. Graph decompositions and translation into generating functions.
10. The Dissymmetry Theorem for trees.
11. The first principle in analytic combinatorics: the position of the singularities and the exponential growth.
12. The second principle in analytic combinatorics: the nature of the singularities and the subexponential growth.
13. Lagrangian schemes and singularity analysis. Universality of the supexponential growth.
14. Maps and rooted maps. Counting formulas by root decomposition. Catalytic variables and the Quadratic Method.
15. The Cori-Vaulequin-Schaeffer Bijection and well-labelled trees.