Schedule for the CIMPA School, 2026

Time table

Date	Time	Activity	Instructor/Details
Mon, Week 1	08:00 - 10:00	**Opening Ceremony**	
	10:00 - 10:30	Coffee Break	
	10:30 - 12:30	**Lecture 1**	Prof. B. Servatius
	12:30 - 14:00	Lunch	
	14:00 - 16:00	**Lecture 2 (Part 1)**	Prof. F. Bassino
	16:00 - 16:30	Coffee Break	
	16:30 - 18:00	**Lecture 1**	Prof. B. Servatius
	18:00 - 20:00	Dinner	
Tues, Week 1	08:00 - 10:00	**Lecture 2 (Part 1)**	Prof. F. Bassino
	10:00 - 10:30	Coffee Break	
	10:30 - 12:30	**Lecture 2 (Part 2)**	Prof. S. Wagner
	12:00 - 14:00	Lunch	
	14:00 - 16:00	**Lecture 1**	Prof. B. Servatius
	16:00 - 16:30	Coffee Break	
	16:30 - 18:00	**Round Table on Gender Issues in Mathematics**	
	18:00 - 20:00	**Welcome Dinner**	
Wed, Week 1	08:00 - 10:00	**Lecture 2 (Part 2)**	Prof. S. Wagner
	10:00 - 10:30	Coffee Break	
	10:30 - 12:30	**Lecture 1**	Prof. B. Servatius
	12:30 - 14:00	Lunch	
	14:00 - 16:00	**Lecture 2 (Part 2)**	Prof. S. Wagner
	16:00 - 16:30	Coffee Break	
	16:30 - 18:00	**Lecture 2 (Part 1)**	Prof. F. Bassino
	18:00 - 20:00	Dinner	
Thurs, Week 1	08:00 - 10:00	**Lecture 2 (Part 2)**	Prof. S. Wagner
	10:00 - 10:30	Coffee Break	
	10:30 - 12:30	**Lecture 3**	Dr. V. Misanantenaina Rakotonarivo
	12:30 - 14:00	Lunch	
	14:00 - 16:00	**Lecture 3**	Dr. V. Rakotonarivo Misanantenaina
	16:00 - 16:30	Coffee Break	
	16:30 - 18:30	**Parallel: Group projects**	
	18:00 - 20:00	Dinner	
Frid, Week 1	08:00 - 10:00	**Lecture 3**	Dr. V. Rakotonarivo Misanantenaina
	10:00 - 10:30	Coffee Break	
	10:30 - 12:10	**Lecture 4**	Dr. A. Dossou-Olory
	12:10 - 12:30	**CIMPA: Actions and Initiatives (Meeting)**	Dr. N. Bédaride (CIMPA representative)
	12:30 - 14:00	Lunch	
	14:00 - 16:00	**Lecture 3**	Dr. V. Misanantenaina Rakotonarivo
	16:00 - 16:30	Coffee Break	
	16:30 - 18:30	**Parallel: Group projects**	
	18:00 - 20:00	Dinner	
Sat, Week 1	All Day	Break Day / **Excursion**	
Mon, Week 2	08:00 - 10:00	**Lecture 4**	Dr. A. Dossou-Olory
	10:00 - 10:30	Coffee Break	

Date	Time	Activity	Instructor/Details
	10:30 - 12:30	**Lecture 5 (Part 1)**	Dr. K. Dadedzi
	12:30 - 14:00	Coffee Break	
	14:00 - 16:00	**Lecture 4**	Dr. A. Dossou-Olory
	16:00 - 16:30	Coffee Break	
	16:30 - 18:00	**Open forum: Mathematics in Africa; Number and Pattern in African Cultures**	
	18:00 - 20:00	Dinner	
Tues, Week 2	08:00 - 10:00	**Lecture 5 (Part 1)**	Dr. K. Dadedzi
	10:00 - 10:30	Coffee Break	
	10:30 - 12:30	**Lecture 6**	Dr. R. Avohou
	12:30 - 14:00	Lunch	
	14:00 - 16:00	**Lecture 5 (Part 1)**	Dr. K. Dadedzi
	16:00 - 16:30	Coffee Break	
	16:30 - 18:30	**Parallel: Group projects**	
	18:00 - 20:00	Dinner	
Wed, Week 2	08:00 - 10:00	**Lecture 6**	Dr. R. Avohou
	10:00 - 10:30	Coffee Break	
	10:30 - 12:30	**Lecture 5 (part 2)**	Prof. E. Andriantiana
	12:30 - 14:00	Lunch	
	14:00 - 16:00	**Lecture 7**	Prof. J. Ben Geloun
	16:00 - 16:30	Coffee Break	
	16:30 - 18:00	**Lecture 6**	Dr. R. Avohou
	18:00 - 20:00	Dinner	
Thurs, Week 2	08:00 - 10:00	**Lecture 5 (Part 2)**	Prof. E. Andriantiana
	10:00 - 10:30	Coffee Break	
	10:30 - 12:30	**Lecture 7**	Prof. J. Ben Geloun
	12:30 - 14:00	Lunch	
	14:00 - 16:00	**Lecture 5 (Part 2)**	Prof. E. Andriantiana
	16:00 - 16:30	Coffee Break	
	16:30 - 18:00	**Lecture 7**	Prof. J. Ben Geloun
	18:00 - 20:00	**Farewell Dinner**	
Frid, Week 2	08:00 - 10:00	**Lecture 7**	Prof. J. Ben Geloun
	10:00 - 10:30	Coffee Break	
	10:30 - 12:30	**Presentation of the groups' projects**	
	12:30 - 14:00	Lunch	
	14:00 - 16:00	**Parallel sessions on selected topics**	
	16:00 - 16:30	Coffee Break	
	16:30 - 18:00	**Parallel sessions on selected topics**	
	18:00 - 20:00	Dinner	
Sat, Week 2	All Day	Break Day	Departure

Lecture syllabi

Lecture 1: Introduction to Combinatorics and Graph Theory

Instructor: Prof. Brigitte Servatius
Duration: 4 lectures (2 hours each)
Reference: *Martin Milanic, Brigitte Servatius and Herman Servatius. Discrete mathematics with logic. London; San Diego; Academic press, 2024.*

Course description

This short course introduces some of the fundamental concepts of discrete mathematics, including finite sets, counting techniques, mathematical induction, coding and cryptography, and graph theory. The emphasis is on developing logical reasoning and problem-solving skills through concrete examples and applications drawn from computer science, communication networks, and combinatorics.

Lecture 2: Enumerative Combinatorics

Lecture 2 Part 1: Enumerative Combinatorics: Exact Enumeration, Formal Power Series, and Symbolic Methods

Instructor: Frédérique Bassino
Duration: 4 lectures (2 hours each, 8 hours total)
References:

1. M. Bóna, *A Walk Through Combinatorics: An Introduction to Enumeration and Graph Theory*, 4th ed., Springer, 2016.
2. H. S. Wilf, *Generatingfunctionology*, 3rd ed., A K Peters, 2005.

Course description

Enumerative combinatorics is concerned with the counting of discrete structures and the development of systematic methods for deriving counting formulas. This short course introduces the fundamental tools of exact enumeration, with a particular emphasis on formal power series and symbolic methods. These techniques provide a powerful framework for translating combinatorial constructions into algebraic equations whose solutions yield counting sequences and generating functions.

Through a variety of classical examples, participants will learn how combinatorial classes can be specified, manipulated, and enumerated using symbolic constructions and generating functions. The course serves as an introduction to modern combinatorial enumeration and provides the foundations for more advanced topics in analytic combinatorics.

Lecture 2 Part 2: Analytic Methods in Enumerative Combinatorics

Instructor: Prof. Stephan Wagner
Duration: 5 lectures (2 hours each, 10 hours total)
References:

- Flajolet, P. and Sedgewick, R., *Analytic Combinatorics*, Cambridge University Press, Cambridge, 2009.
- Melczer, S., An invitation to analytic combinatorics—from one to several variables. Springer, Cham, 2021.

Course description

Generating functions are among the most powerful tools in modern enumerative combinatorics. They not only encode counting sequences in a compact algebraic form but also provide deep insights into the asymptotic behaviour of combinatorial structures through their analytic properties. This course introduces the fundamental principles of asymptotic enumeration, focusing on the relationship between generating functions, their singularities, and the growth of their coefficients.

Participants will learn how analytic techniques can be used to derive asymptotic estimates for counting sequences and how these methods apply to a wide range of combinatorial structures. Particular emphasis will be placed on singularity analysis, one of the central tools of analytic combinatorics.

Lecture 3: Graph Algorithms and Programming

Instructor: Dr. Valisoa Razanajatovo Misanantenaina Rakotonarivo
Duration: 4 lectures (2 hours each, 8 hours total)
Software: Python and the `NetworkX` library
Reference:

1. A. A. Hagberg, D. A. Schult, and P. J. Swart, *Exploring Network Structure, Dynamics, and Function using NetworkX*, Proceedings of the 7th Python in Science Conference, 2008.
2. A. M. J. van Steen, *Graph Theory and Complex Networks: An Introduction*, Maarten van Steen, 2010.
3. J. Kleinberg, and E. Tardos, *Algorithm Design*, Addison-Wesley, 2005.

Course description

Graphs provide a natural mathematical framework for modeling networks, relationships, and interactions arising in computer science, engineering, biology, social sciences, and many other disciplines. This hands-on course introduces participants to graph algorithms and computational graph theory using Python and the `NetworkX` library, one of the most widely used tools for network analysis.

The course combines theoretical concepts with practical programming exercises. Participants will learn how to construct, manipulate, visualize, and analyze graphs, as well as how to implement and apply classical graph algorithms. Particular emphasis will be placed on distance-based graph parameters and real-world applications of graph analysis.

Lecture 4: Extremal Graph Theory: Generalities

Instructor: Dr. Audace A. V. Dossou-Olory
Duration: 3 lectures (2 hours each)
Reference:

- N. Alon, M. Krivelevich (2008), *Extremal and Probabilistic Combinatorics*, pp.562–575
- B. Bollobás (2004), *Extremal Graph Theory.*
- B. Bollobás (1998), *Modern Graph Theory*, pp.103–144
- R. Wenger (1991), *Extremal graphs with no C4, C6 and C1*0, p.113–116.

Course description

In this course, we will introduce basic instances of extremal graph theory statement, and study the most classical type of extremal question in graphs, where we impose a natural property of graphs (some constraint on the graph) and ask how many edges it can have subject to that constraint. Our main focus will be on forbidding some fixed subgraph. This notion was first studied by Mantel in 1907. We will establish both lower and upper (exact or asymptotic) bounds on the maximum number of edges of a n-vertex graph that does not contain a given fixed graph as a subgraph. In particular, we will explore properties of Turán graph, the Erdös-Stone-Simonovits theorem, the Kövari-Sós-Turán theorem, Klein's theorem and Brown theorem. We will conclude the lectures with the exploration of Ramsey-type problems in a way of combinatorial exercices.

Lecture 5: Extremal Aspects in Spectral Graph Theory

Instructors:

- Prof. Eric Andriantiana
- Dr. Kenneth Dadedzi

Duration: 6 lectures (2 hours each)

Reference:

- Biggs, N. L. Algebraic Graph Theory. 2nd ed. Cambridge Mathematical Library. Cambridge: Cambridge University Press, 1993.
- Cvetković, D. (Ed.). (2008). Zbornik radova (Vol. 13(21)). Beograd: Matematički institut SANU.
- EODA, Energy, Hosoya index and Merrifield-Simmons index of trees with prescribed degree sequence, Discrete Appl. Math. 161 (2013) 724-741.
- EODA and S. Wagner, Spectral moment of trees with given degree sequence, Linear Algebra Appl. 439 (2013) 3980-4002.
- Cvetković, Dragoš M., Peter Rowlinson, and Slobodan Simić. An introduction to the theory of graph spectra. Vol. 75. Cambridge: Cambridge university press, 1945.

Course description

This advanced course explores several modern directions in graph theory, bringing together combinatorial, spectral, and extremal perspectives. Participants will be introduced to the theory of graph spectra. Moreover, they will study graph energy and its connections with matchings and independent sets, spectral moments and spectral invariants such as the spectral radius and Estrada index, and fundamental results in extremal graph theory. These topics play an important role in contemporary graph theory and have applications in network science, computer science, chemistry, and combinatorial optimization.

The course combines theoretical developments with examples and problem-solving sessions, enabling participants to acquire both a solid theoretical understanding and practical techniques for tackling advanced graph-theoretic problems.

Part I: Spectral Graph Theory: Spectral-Based Graph Invariants (Dr. K. Dadedzi)

Part II: Selected Applications of Spectral Graph Theory: Energy of graphs, Spectral Moments, Number of Walks and Estrada Index (Prof. E. Andriantiana)

Lecture 6: Matroid Theory

Instructor: Dr. Rémi Cocou Avohou
Duration: 3 lectures (2 hours each, 6 hours total)
References:

- **James Oxley** — *Matroid Theory*, Wiley, 1987.
  Matroid Theory, 2nd edition, Oxford Graduate Texts in Mathematics, Oxford University Press, 2011.
- **Neil White** — *Combinatorial Geometries*, Wiley, 1987.
  Theory of Matroids, Encyclopedia of Mathematics and its Applications, Cambridge University Press, 1986.
- **Günter M. Ziegler** — *Lectures on Polytopes*, Wiley, 1987.
  Lectures on Polytopes, Graduate Texts in Mathematics 152, Springer, 1995.

Course description

Matroid theory is a central area of modern combinatorics that provides a unifying framework for studying independence in mathematics. Originating from attempts to abstract the notion of linear independence in vector spaces, matroids connect graph theory, geometry, optimization, coding theory, and polyhedral combinatorics. They provide the theoretical foundation for greedy algorithms and offer powerful tools for understanding combinatorial structures.

This introductory course presents the fundamental concepts of matroid theory, beginning with motivating examples from graph theory and optimization. Participants will learn the basic definitions and properties of matroids, explore representable matroids and their geometric interpretations, and study important combinatorial invariants such as the Tutte polynomial and chromatic polynomial. The course will also introduce geometric and polyhedral aspects of matroids, including matroid base polytopes and Ehrhart polynomials.

Lecture 7: Topological Graph Theory

Instructor: Prof. Joseph Ben Geloun
Duration: 4 lectures (2 hours each)
References:

- **J. L. Gross & T. W. Tucker** — *Topological Graph Theory*, Wiley, 1987.
  The standard reference: embeddings, rotation systems, voltage graphs, genus.
- **S. Lando & A. Zvonkin** — *Graphs on Surfaces and Their Applications*, Springer, 2004.
  Maps, dessins d'enfants, matrix models, and connections to algebraic geometry.
- **B. Mohar & C. Thomassen** — *Graphs on Surfaces*, Johns Hopkins UP, 2001.
  Rigorous treatment of surface embeddings, Kuratowski, graph minors.
- **R. Diestel** — *Graph Theory*, 5th ed., Springer, 2017. **(free online)**
  Chapters 4 (planar graphs) and 12 (graph minors) are essential.
- **J. Ellis-Monaghan & C. Merino** — *Graph polynomials and their applications I & II*, in *Structural Analysis of Complex Networks*, Birkhäuser, 2011.
  Excellent survey, freely available on arXiv (0803.3079, 0806.4699).

Course description

Topological graph theory studies the interaction between graph theory and topology through the embedding of graphs on surfaces. It provides powerful tools for understanding the structure of graphs by examining their topological properties, such as genus and Euler characteristic, and their associated combinatorial invariants. Among these invariants, the Tutte polynomial occupies a central position, linking graph theory, topology, matroid theory, statistical physics, and knot theory.

This course introduces the fundamental concepts of topological graph theory, including graph embeddings, planar graphs, surface topology, graph minors, and graph polynomials. Particular emphasis will be placed on the Tutte polynomial and its applications to graph coloring, spanning trees, connectivity, and topological properties of embedded graphs. The course concludes with modern perspectives on maps and topological invariants arising from embedded combinatorial structures.