

# Grad seminar – Topics for Master’s Students

If you are a Master’s student and would like to give an expository talk in the Grad Seminar, here are some ideas for topics you could talk about. Don’t feel like you have to restrict yourself to this list, though – if you have a different topic that you’d like to talk about, feel free to email one of the organizers and suggest it!

## Algebra

- Galois, Čech, Tate, or group cohomology (choose one)
- $K$ -theory and the Witt ring
- Kähler differentials and the Jacobian criterion
- Spectral sequences (cohomological descent; simplicial sheaves)
- Polynomial invariant theory
- Quivers (representations; path algebras)

## Algebraic Geometry

- Divisors and blowup
- Intersection of curves
- Introduction to étale, Nisnevich, fppf, fpqc, or crystalline cohomology (choose one)
- Moduli spaces (Grassmannians; moduli space of elliptic curves)

## Analysis

- Optimization and Monge-Ampère equations
- ODE’s and manifolds
- Theory of distributions (applications to solving PDE’s; Fourier transforms of distributions)

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## Complex Analysis

- Riemann-Hilbert problems
- The Riemann-Roch theorem and applications
- Theta functions
- Divisors on Riemann surfaces and line bundles

## Functional Analysis

- The Banach-Mazur theorem
- The Krein-Milman theorem
- Gelfand theory for commutative Banach algebras and commutative  $C^*$  algebras
- The Hellinger-Toeplitz theorem

## Category Theory

- Quillen's Theorems A and B
- Moore homology
- Derived categories and applications to (co)homology

## Combinatorics

- Matroids
- Blueprints and pastures
- Hyperplane intersections
- Toric varieties

## Differential geometry

- The Gauss-Bonnet theorem
- Homogenous spaces and the principal orbit theorem
- Hamiltonian vector fields
- The Euler-Lagrange equation and applications
- Vector bundles and characteristic classes
- The Poincaré-Hopf theorem

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## Number Theory

- Adeles and ideles
- $j$ -functions of elliptic curves and complex multiplication
- $L$ -functions and modular forms
- Dessins d'enfants
- The circle method

## Topology

- Homology and classification of Lens spaces
- Arithmetic topology (number fields, 3-manifolds, and knots)
- Étale spaces and sheaves
- Poincaré duality
- The Hodge theorem