

Oral Qualifying Examination Syllabus

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Topic 1: Algebraic and Geometric Topology

Part I: Algebraic Topology

- Fundamental Group (1)
- Van Kampen Theorem (1)
- Covering Spaces (1)
- Homology groups (1)
- Exact Sequences of Homology Groups (1)
- Cellular Homology (1)
- Cellular and Simplicial Approximation (1)
- Cohomology ring (1)
- Künneth formula (1)
- Cup and Cap Products (1)
- Poincaré Duality (1)

Part II: Manifold Topology

- Schoenflies Theorem (3)
- Morse Functions (2)
- Handle Decomposition of a manifold (2)
- h -cobordism theorem (2)
- Poincaré conjecture in high dimensions (2)
- Wall's finiteness obstruction (3)
- Whitehead and Hurewicz theorems (3)
- Stalling's Characterization of Euclidean Space (3)

- Simplicial Morse Theory and Finiteness Properties of Groups (4)
- Borel-Moore cohomology of complex varieties (6)

Topic 2: Algebraic Geometry

Part I: Basic Notions

- Zariski Topology, Affine and Projective Varieties (5)
- Algebraic varieties and complete varieties (5)
- Morphisms and rational maps (5)
- Nonsingular Varieties and curves (5)
- Hilbert function and Hilbert polynomial of a variety (5)
- Bezout's Theorem (5)
- Sheaves and Sheafification (5)
- Quasi-coherent and coherent Sheaves and varieties (5)
- Divisor Group and Class Group of a normal variety (5)
- Picard Group and Cartier Class group of a normal variety (5)

Part II: Cohomology of Grassmannians

- Grassmann Varieties and Schubert Varieties (6)
- The Pieri Formula and Littlewood-Richardson rule (6)
- Schur functions (6)

References:

- 1) A. Hatcher, *Algebraic Topology*
- 2) J. Milnor, *Lectures on the h-Cobordism Theorem*
- 3) Geometric Topology notes by S. Ferry
- 4) M. Bestvina and N. Brady, *Morse Theory and finiteness properties of groups*
- 5) Online Algebraic Geometry course notes by A. Buch

- 6) W. Fulton, *Young Tableaux*
- 7) R. Hartshorne, *Algebraic Geometry* (supplemental reference)