

# Oral Qualifying Examination Syllabus

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## Algebraic Topology

### I. Homology

1. Singular homology
2. Homotopy invariance
3. Mayer-Vietoris sequence
4. Relative homology groups
5. Excision
6. Finite CW complexes
7. Skeletal homotopy
8. Eilenberg-Steenrod axioms

### II. Cohomology and products

1. Singular Cohomology
2. Künneth formula
3. Cup product
4. Hopf invariant
5. Cap product

### III. Manifolds and duality

1. Manifolds and orientation
2. Thom isomorphism theorem
3. Poincaré duality

# Commutative Algebra

## I. Basic commutative algebra

1. Localization of rings and modules
2. The Hilbert Nullstellensatz
3. Associated primes and primary decomposition
4. Integral dependence and valuations
5. DVRs, Dedekind rings, and Krull rings
6. Graded rings and modules
7. Hilbert functions and Hilbert polynomials

## II. Cohen-Macaulay Rings

1. Regular sequences
2. Grade and depth
3. Depth and projective dimension
4. Cohen-Macaulay rings and modules
5. Complete intersections

## III. Homological Algebra

1. Chain complexes
2. Chain homotopies
3. Projective and injective resolutions
4. Left and right derived functors
5. Adjoint functors and left/right exactness
6. Tor and Ext
7. Dimensions
8. Koszul complexes
9. Local cohomology