Syllabus for Oral Qualifying Exam
James Dibble

Major Topic: Differential and Riemannian Geometry

Differential geometry
- Smooth manifolds
- Vector bundles
- Lie brackets and derivatives
- Submersions, immersions, and embeddings
- Integration and Stokes's Theorem
- de Rham cohomology
  - de Rham Theorem
  - Poincaré duality

Riemannian geometry
- Riemannian metrics
- First and second variation formulas
- Levi-Civita connection
- Geodesics and the exponential map
  - Gauss Lemma
  - Hopf-Rinow Theorem
- Jacobi fields
- Parallel transport
- Gauss-Bonnet Theorem
- Comparison geometry
  - Spaces of constant sectional curvature
  - Comparison estimates
  - Conjugate points
  - Cartan-Hadamard Theorem
  - Preissmann’s Theorem
  - Bonnet-Myers Theorem
  - Synge’s Theorem

References:
Lee, John. *Introduction to Smooth Manifolds.*
Petersen, Peter. *Riemannian Geometry.*
Minor Topic: Algebraic Topology

Fundamental group
   Homotopy invariance
   Seifert-Van Kampen Theorem

Covering spaces
   Lifting properties
   Deck transformations
   Classifications

Singular homology and cohomology
   Degree of a map
   Euler characteristic
   Exact sequences and excision
   Mayer-Vietoris sequence

References:
Lee, John. *Introduction to Topological Manifolds.*