

Oral qualifying exam syllabus

Sriram Raghunath

1 Major topics

Algebraic topology

1. Fundamental groups and homotopy
2. Van Kampen's theorem
3. Covering spaces and deck transformations
4. Simplicial, singular and cellular homology
5. Exact sequence of a pair
6. Mayer-Vietoris sequence
7. Excision
8. Universal coefficient theorem
9. Cup product
10. Cap product
11. Kunneth formula
12. Poincare duality
13. Alexander duality
14. Higher homotopy groups
15. Whitehead's theorem
16. Cellular approximation
17. CW approximation
18. Hurewicz theorem
19. Long exact sequence of a fibration
20. Eilenberg MacLane spaces and connections between homotopy and cohomology

Reference: Algebraic Topology by Allen Hatcher

Knot theory

1. Basic definitions and examples
2. Seifert surfaces and knot factorization
3. The Jones Polynomial
4. Basic properties of alternating links and their diagrams
5. The Alexander invariants and the Conway polynomial
6. Cyclic branched covers and the Goeritz matrix
7. The Arf invariant and its relation with the Jones polynomial
8. The knot group
9. Surgery on links and the Lickorish-Wallace theorem

References:

1. An Introduction to Knot Theory by W.B.R. Lickorish
2. Knots and Links by Dale Rolfsen

2 Minor topics

Riemann surfaces

1. Basic definitions and examples
2. Maps between Riemann surfaces
3. Analytic continuation and Riemann surfaces of holomorphic functions
4. Monodromy and the Riemann existence theorem
5. Differential forms and the operators d , ∂ and $\bar{\partial}$
6. Riemann-Hurwitz formula and degree genus formula
7. Main theorem for compact Riemann surfaces
8. Abel-Jacobi theorem
9. Riemann-Roch theorem for Riemann surfaces
10. Uniformization of Riemann surfaces
11. Line bundles and divisors on Riemann surfaces
12. The first Chern class and curvature of a line bundle

References:

1. Riemann Surfaces by Simon Donaldson
2. Lectures on Riemann Surfaces by Otto Forster

4-manifolds and Kirby Calculus

1. Basic definitions and examples
2. Surfaces in 4-manifolds
3. Blow up and resolution of intersections and singularities
4. Handlebodies and handle decompositions
5. Heegard splittings of 3 manifolds
6. Kirby diagrams
7. Handle moves and Kirby calculus
8. Relative Kirby calculus

Reference: 4-manifolds and Kirby Calculus by Gompf and Stipsicz