

Syllabus for the Qualifying Review in COMBINATORICS

The examination will be based on the following topics:

1. Graph theory: basic properties and definitions of graphs and subgraphs, Eulerian and Hamiltonian graphs, matchings, coverings, independent sets, trees, connectivity, shortest paths, graph colouring including Vizing and Brooks Theorems, Ramsey's theorem, random graphs
2. Design theory: basic properties of balanced incomplete block designs (BIBDs), Fisher's inequality, basic properties of Steiner and Kirkman triple systems, covering and packing designs, mutually orthogonal Latin squares (MOLS), transversal designs (TDs) and their relation to finite planes, group divisible designs (GDDs), pairwise balanced designs (PBDs), Bose and Skolem constructions for BIBDs, Wilson's fundamental construction, some recursive constructions for triple systems, difference sets and difference methods for constructing designs, basic properties of Room squares
3. Enumeration: generating functions, principle of inclusion and exclusion, partitions, recurrence relations, distributions, Stirling numbers, Polya counting theorem, systems of distinct representatives

References:

- D. West, Introduction to Graph Theory (2nd ed), Prentice Hall, 2001
- J. Bondy and U. Murty, Graph Theory with Applications, Macmillan Press, 1977
- R. Diestel, Graph Theory, Springer, 1997
- I. Anderson, Combinatorial Designs and Tournaments, Oxford Science Publications, 1993
- C. Lindner and C. Rodger, Design Theory, CRC Press, 1997
- T. Beth, D. Jungnickel and H. Lenz, Design Theory, Cambridge University Press, 1993
- P. Cameron, Combinatorics: Topics, Techniques, Algorithms, Cambridge University Press, 1996

Additional References:

- Ryser, Combinatorial Mathematics, MAA, 1963
- Wallis, Combinatorial Designs, Dekker, 1988