Suggested research topics for term papers

1) Bollobás’s and McKay’s upper bounds to the independence ratio of random regular graphs. Also, Frieze and Luczuk prove matching lower bounds for large $d$.

2) Shamir and Spencer’s proof that the chromatic number of random graphs is concentrated on 4 values. Also, Luczuk’s improvement of this to 3 values.

3) A project on expander graphs with topics such as Cheeger’s inequality, the expander mixing lemma and some applications.

4) The Alon-Boppana theorem and Hoory’s generalization to non-regular graphs. Also, Serre’s theorem on the second largest eigenvalue.

5) The Alon-Roichman theorem that random Cayley graphs are expanders.

6) The Lovasz local lemma with applications and generalizations.

7) Card shuffling and mixing times for card shuffling.

8) Simple random walk on $\mathbb{Z}$ with topics such as the Ballot theorem, the reflection principle, gambler’s ruin phenomenon and arcsine law for last zero. Durrett has a nice treatment.

9) Random permutations: cycle structure and the number of cycles of fixed lengths having a limiting Poisson distribution. Wilf’s generatingfunctionology has a very nice exposition on this. For a more challenging topic, Erdős and Turán’s paper on the order of a random permutation.

10) High dimensional permutations following the recent work of Linial and Luria.

11) The assignment problem and proof of Parisi’s conjecture via combinatorial methods due to Wastlund.

12) Some elementary topics about the largest increasing subsequence in a random permutation following the book of Romik.

13) Mixing time of random walks on finite graphs following the book of Levin, Peres and Wilmer.

14) Isoperimetric inequality for random regular graphs, following the paper of by Kolesnik and Wormald.