Description: This is a graduate-level course introducing the use of randomization methods for the design and analysis of network algorithms. In its first part, the course will cover core material, such as tail inequalities, balls and bins problems, and random graphs, as well as classical applications, such as the coupon collector’s problem, hashing, and Bloom filters. In its second part, the course will delve into more advanced topics, such as the probabilistic methods, random walks, and martingales. An important component of the course is a final project through which students will apply the knowledge acquired during the course to investigate research problems of current interest in networking.

Expected outcomes: As an outcome of completing this course, it is expected that students will
1. Understand the importance and role of randomization in the design of modern network algorithms.
2. Understand terminology related to the probabilistic analysis of network algorithms and be able to communicate ideas about them.
3. Master core randomization methods and be able to apply them to new research areas.
4. Apply computer tools to implement network algorithms and appreciate the performance gains achievable using randomization.

Topics: We expect to cover the following topics in the class:
- Introduction to randomized algorithms: computational complexity, Monte Carlo and Las Vegas algorithms
- Probability review: axioms, random variables, moments, moment generating functions.
- Examples and analysis of simple randomized algorithms: min-cut and median computations, the coupon collector's problem.
- Tail inequalities and Chernoff bounds.
- Balls and bins models with applications to hashing. Bloom filters
- The probabilistic method: basic counting argument, expectation argument, the second moment method.
- The Lovasz Local Lemma. Applications: edge-disjoint paths, satisfiability.
- Advanced techniques (time permitting): Monte Carlo sampling methods, almost uniform sampling, coupling of Markov chains, variation distance, and mixing times.