Title of the course:
Randomized Algorithm Design

Credit requirement:(L-T-P: 3-0-0, Credit: 3)

Please select the committee for Approval: PGPEC

Name of the Dept: CSE

Please Specify the Level of the Subject: PG level

Whether the subject will be offered as compulsory or elective: Elective

Prerequisite(s) for the subject, if any
(Please give the subject numbers and names): Algorithms-I (CS21003)

Course Objective

Randomization has been serving as a central idea in algorithm design in particular and theoretical computer science in general. Indeed, randomized algorithms are often tend to be simple and thus practically useful than their deterministic counter parts yet provides matching guarantees. This is the case, for example, for randomized quick sort algorithm, randomized minimum cut algorithm, etc. Other than algorithm design, randomization has also been used to come up with path breaking proof techniques, for example, probabilistic methods, probabilistically checkable proof, etc. in theoretical computer science. In this course, we will introduce these probabilistic techniques with state of the art applications to the students so that they can apply it in their research whenever needed.

Study Materials
In this course, we will use the following textbooks. We will also use online study materials and research articles.

Books:
1. Randomized Algorithms: Rajeev Motwani, Prabhakar Raghavan
2. Probability and Computing: Randomization and Probabilistic Techniques in Algorithms and Data Analysis by Eli Upfal and Michael Mitzenmacher
3. Articles from leading CS conferences, for example, Symposium of Theory of Computation (STOC), Foundations of Computer Science (FOCS).

Syllabus:

Review of basic probability: 2 hours
Tail bounds - Markov inequality, Chebbyshev's inequality, Hoeffding bound: 3 hours
Martingale: 2 hours
Coupon collector's problem: 2 hours

Yao's Minimax Theorem: 2 hours
von Neumann's Theorem on zero sum games: 2 hours
Hashing: 2 hours
Bloom filter: 2 hours
Locality sensitive hashing and its application to nearest neighbor problem: 2 hours
Algebraic Techniques: 4 hours
Markov Chain and Random Walk: 5 hours
Johnson Lindenstrauss lemma: 2 hours
Expander graphs: 2 hours
Probabilistic approximation of metric by tree metric: 2 hours
Derandomization: 2 hours
Probabilistic method: 4 hours
Lovasz Local Lemma: 2 hours

Names of the faculty members of the Department/Centers/School who have the necessary expertise and will be the willing to teach the subject (Minimum two faculty members should be willing to teach the subject)

Prof. Palash Dey, Prof. Swagato Sanyal

Do the contents of the subject have an overlap with any other subject offered in the Institute?

This course has an overlap of 5% with Complex Network (CS60078).

Reasons for offering the new subject in spite of the overlap: The Complex Network (CS60078) course discusses empirically findings of random walks on graphs. In comparison, we will prove theoretical guarantees for random walks on Markov chains.