CS345/CS345A Design and Analysis of Algorithms 3-0-0-0-9

Course Objectives: The aim of the course is to help students acquire skills for the design and analysis of algorithms and data structures. In order to achieve this objective, various algorithms and data structures for various fundamental problems will be discussed. In addition various techniques for analysing an algorithm will also be covered. The emphasis will laid on designing algorithms with provable guarantee on their correctness and efficiency.

Course Contents: The course will cover the following topics.

1. Divide and Conquer (Advanced applications like polynomial multiplication)
2. Greedy Strategies (Advanced applications like Huffman coding) with emphasis on a generic proof of correctness.
3. Dynamic Programming: Applications like Bellman Ford Algorithms
4. A gentle exposure to some advanced data structures (Fibonacci heaps, augmented data structures, interval trees).
5. Graph algorithms: all-pairs shortest paths, Topological ordering of DAG, DFS in directed graphs, strongly connected components.
6. Amortized Analysis.
7. Network Flows: Ford Fulkerson algorithm, Max-flow Min-cut theorem, polynomial time algorithms for max-flow. A large number of applications will be discussed.
8. Pattern matching.
9. Notion of intractability: NP-completeness, reduction used to show NP-completeness of some problems.
10. Based on availability of time and interest of the class, a few topics from the following list will also be covered
    a. Bipartite matching algorithm for Hopcroft and Karp
    b. Stable matching
    c. Linear programming
    d. Approximation algorithms
    e. Randomized algorithms

Course Instructor: Surender Baswana
Course Lectures: M,W,F 9-10AM in RM101
Office hours: to be fixed on demand through email

Course Organization: All notices of the course will be communicated through email. The course material (lectures, assignments, practice-sheets) will be hosted on https://moodle.cse.iitk.ac.in.

Marks distribution: There will be **6** Theoretical assignments. In addition, there will be a special assignment involving re-inventing an algorithm for a fundamental problem (smallest enclosing circle problem) and analysing it empirically. There will be two **long hours** exams so that students may perform their best without pressure of time constraints. There will also be two quizzes. The distribution of marks will be as follows.

- Assignments - 25%
- Quiz 1 - 10% **[3 PM on 20 August]**
- MidSem Exam - 25%
- Quiz 2 - 10% **[3 PM on 22 October]**
- EndSem Exam - 30%

Each student must keep the graded copies of his/her assignments, quizzes, as well as exams till 30th November. This is to avoid any problem arising out of loss of data in some rare circumstances.

Attendance Policy: **Attendance is compulsory for the first half of this course.** Let me elaborate on this policy a bit more. If any student has any medical/personal/professional problem, he may miss the class. However, he/she must be ready to produce the documentary evidence for the same. For example, if any student has some marriage function at home, or any student has to attend a workshop somewhere, he may meet me to seek permission for leave. If a person is not medically well and misses the class, he must produce the prescription from the health center on the next class. Basically, if you are in the campus and medically fit, you must attend the lectures of CS345. **There will be a penalty of 10% marks for every if you lecture a student missed without any one of the proper reasons mentioned above.** If a student scores less than 50% marks in the mid-semester exam, he/she must attend all the remaining classes.

Academic Dishonesty: Academic integrity is taken very seriously by the instructor. Any kind of copying or cheating in assignments, exams or otherwise will suffer severe penalty. Penalty may range from percentage points of total course to **F grade** in the course and reporting of the concerned students to DOAA, which may lead to termination.

Passing Criteria : One must obtain **at least 25%** of marks in the exams and overall 33% marks in the course. Otherwise, he/she may fail the course irrespective of his/her performance in the assignments.

References : Although the lectures will be fully self contained, the students may refer to the following books (indian editions).

1. **Algorithm Design** by *Kleinberg and Tardos*. Publishers: Pearson Educations India.
2. **Introduction to Algorithms** by *Cormen, Leiserson, Rivest, and Stein*. Publishers: Prentice-Hall India.