Second semester 2016-17

Course Handout Part II

In addition to Part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

CourseNo.: **CS F364**

CourseTitle: **Design & Analysis of Algorithms**

Instructor in Charge: **Abhishek Mishra**

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Course Objectives: To learn about some basic algorithm design techniques like **Divide and Conquer**, **Greedy Algorithms**, **Dynamic Programming**, etc. To learn about **Computational Complexity**. To learn about some advanced algorithm design techniques like **Approximation Algorithms**, and **Randomized Algorithms**. To learn about **Number Theoretic Algorithms**.

Text Book:

[T1] T.H. Cormen, C.E. Leiserson, R.L. Rivest, C. Stein, Introduction to Algorithms, 3rd Edition, PHI, 2009.

Reference Books:

[R1] J.Kleinberg, E. Tardos, Algorithm Design, Pearson, 2013. Lecture slides of the book are available online at: **http://www.cs.princeton.edu/~wayne/kleinberg-tardos/pearson/**

[R2] D.P. Williamson, D.B. Shmoys, The Design of Approximation Algorithms, Cambridge University Press, 2010. Available online at: **http://www.designofapproxalgs.com/book.pdf**

[R3] S. Arora, B. Barak, Computational Complexity: A Modern Approach, 2009, Cambridge University Press. Available online at: **http://theory.cs.princeton.edu/complexity/book.pdf**

Lecture Plan:

Lectures	Topics
1	**Algorithm Design:** Introduction, Analysis of Insertion sort and Merge sort
2	**Algorithm Design:** Correctness of an algorithm, Growth of a function, Asymptotic notation
3	**Algorithm Design:** Divide and conquer, Strassen's Algorithm, Solving recurrence relations, Master Method
4	**Algorithm Design:** Quick sort, and performance analysis.
5	**Algorithm Design:** Randomized quick sort and performance analysis
6	**Algorithm Design:** Lower bounds of sorting, sorting in liner time
7	**Algorithm Design:** Median and order statistics, selection in worst case liner time
8	**Algorithm Design:** Direct addressing, hashing with chaining, Universal Hashing, Open addressing
9	**Algorithm Design:** Binary Search Tree and its Expected height
10	**Algorithm Design:** Red-Black Trees, Expected height, Insertion, deletion.
11	**Algorithm Design:** Augmentation data structure, retrieval by rank, interval trees
12	**Algorithm Design:** Dynamic Programming, matrix chain multiplication. elements of DP, LCS
13	**Algorithm Design:** Greedy Algorithm, activity selection, elements of greedy algorithm, Huffman code
14	**Algorithm Design:** Amortized Analysis, binary counter

	increment, multipop in stack,
15	**Algorithm Design:** B tree
16	**Algorithm Design:** Fibonacci Heap
17	**Algorithm Design:** Shortest path in graph, Bellman Ford , Floyd-Warshell algorithm
18	**Algorithm Design:** Maximum Flow
19	**Algorithm Design:** Linear Programming
20	**Computational Complexity:** The complexity class P.
21	**Computational Complexity:** The complexity class NP.
22	**Computational Complexity:** Polynomial time reductions. The complexity classes NP-Complete, and NP-Hard. The Satisfiability problem.
23	**Computational Complexity:** Cook-Levin Theorem
24	**Computational Complexity:** NP-Completeness of 3SAT, 0/1 Integer Programming, and Independent Set.
25	**Approximation Algorithms:** NP Optimization problems. Definition of Approximation Algorithms. A 2-approximation algorithm for the Cardinality Vertex Cover problem. A 2-approximation algorithm for the Weighted Vertex Cover problem.
26	**Approximation Algorithms:** LP-Rounding algorithm for Set Cover. Primal LP, Dual LP, LP-Duality Theorem, Weak Duality Theorem, and Complementary Slackness Conditions.
27	**Approximation Algorithms:** Dual-Rounding algorithm for Set Cover. Primal-Dual algorithm for Set Cover.
28	**Approximation Algorithms:** PTAS, and FPTAS. FPTAS for the 0/1 Knapsack problem.
29	**Approximation Algorithms:** Complexity Classes for Approximation.
30	**Randomized Algorithms:** Randomized Complexity Classes. Markov and Chebyshev Inequalities. Monte Carlo and Las Vegas Algorithms.
31	**Randomized Algorithms:** Error Reduction of Monte Carlo Algorithms. Randomized Global Minimum Cut Algorithm.

32	**Randomized Algorithms:** Chernoff Bounds. Randomized Load Balancing Algorithm.
33	**Randomized Algorithms:** Randomized Approximation Algorithm for MAX 3SAT.
34	**Number Theoretic Algorithms:** Euclid's Extended GCD Algorithm.
35	**Number Theoretic Algorithms:** Modular Exponentiation Algorithm.
36	**Number Theoretic Algorithms:** Miller-Rabin Randomized Primality Testing Algorithm
37	**Number Theoretic Algorithms:** Pollard's Rho Heuristic for Factorization.

Evaluation:

Component	Mode	Weightage	Duration	Remarks
Quiz 1	Open Book	10%	40 minutes	In February
Mid Semester Exam	Closed Book	30%	90 minutes	10/03, 9:00 – 10:30
Quiz 2	Open Book	10%	40 minutes	In March
Quiz 3	Open Book	10%		In April
Comprehensive Exam	Closed Book	40%	180 minutes	12/05, 8:00 – 11:00

Open Book Policy: Only hard copies are allowed (lecture notes, text book, or reference books).

Make-up Policy: Make-up exam may be arranged only in genuine cases with prior permission.

Malpractise Regulation: A student will get 0 if found cheating.

Chamber Consultation Hour:
Abhishek Mishra: 11:00 to 12:00 on Saturdays (6121S).
Kamlesh Tiwari: 11:00 to 12:00 on Saturdays (6120N).

Notices: All notices will be posted on Nalanda.