BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus
AUGS/ AGSR Division

SECOND SEMESTER 2019-20
COURSE HANDOUT

Date: 06.01.2020

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

Course No : **CS F364**

Course Title : **Design & Analysis of Algorithms**
Instructor-in-Charge : **Abhishek Mishra**
Instructor(s) : **Kamlesh Tiwari**
Tutorial/Practical Instructors: Ravi Kant

1. Course Description: The course gives an introduction to some algorithm design techniques.

2. Scope and Objective of the Course: To learn about some basic algorithm design techniques like **Divide and Conquer**, **Greedy Algorithms**, **Dynamic Programming**, and **Network Flow Algorithms**. 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**.

3. Text Book:
[T1] T.H. Cormen, C.E. Leiserson, R.L. Rivest, C. Stein, Introduction to Algorithms, 3rd Edition, PHI, 2012.

4. 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**

[R4] E. Horowitz, S. Sahni, S. Rajasekaran, Fundamentals of Computer Algorithms, Second Edition, 2007, Universities Press.

5. Course Plan:

Lectures	Topics
1	Introduction, Asymptotic Notations, Analysis of Insertion sort and Merge Sort.
2	The Defective Chessboard Problem. Karatsuba’s Multiplication Algorithm.
3	Strassen’s Matrix Multiplication Algorithm.
4	Polynomial Representations, Evaluating a Polynomial using Horners’ Rule, Interpolation using Gaussian Elimination.
5	Discrete Fourier Transform. Fast Fourier Transform Algorithm.
6	The Fractional Knapsack Problem.
7	Huffman Encoding.
8	Optimality of Huffman Encoding.
9	Matroids.
10	Application of Matroids.
11	The 0/1 Knapsack Problem.
12	The Traveling Salesman Problem.
13	Matrix Chain Multiplication.
14	Longest Common Subsequence.
15	Optimal Binary Search Trees.
16	Flow Shop Scheduling.
17	The Maximum Flow Problem and the Ford-Fulkerson Algorithm.
18	Maximum Flows and Minimum Cuts in a Network.
19	The Bipartite Matching Problem.
20	Disjoint Paths in Directed and Undirected Graphs.
21	The Complexity Class P.
22	The Complexity Class NP.

23	Polynomial Time Reductions. The Complexity Classes NP-Complete and NP-Hard. The Satisfiability Problem.
24	Cook-Levin Theorem.
25	NP-Completeness of 3SAT, 0/1 Integer Programming, and Independent Set.
26	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.
27	LP-Rounding Algorithm for Set Cover. Primal LP, Dual LP, LP-Duality Theorem, Weak Duality Theorem, and Complementary Slackness Conditions.
28	Dual-Rounding Algorithm for Set Cover. Primal-Dual Algorithm for Set Cover.
29	PTAS and FPTAS. FPTAS for the 0/1 Knapsack Problem.
30	Complexity Classes for Approximation.
31	Probability, Random Variables, and Expectation. Linearity of Expectation.
32	The Randomized Complexity Classes BPP, RP, co-RP, and ZPP.
33	Markov's Inequality, Chebyshev's Inequality, and Chernoff's Bounds.
34	Atlantic City, Monte Carlo, and Las Vegas Algorithms.
35	The Birthday Paradox.
36	Divisibility.
37	Euclid's Extended GCD Algorithm.
38	Congruences, Fermat's Theorem, and Euler's Theorem.
39	Modular Exponentiation Algorithm.
40	Pollard's Rho Factorization Algorithm.

6. Evaluation Scheme:

Component	Duration	Weightage	Date & Time	Nature of component

		(%)		(Close Book/ Open Book)
Mid-Semester Test	90 Min.	28	5th March, 14:00 - 15:30	Open Book
Comprehensive Examination	3 H	40	11th May, 8:00 - 11:00	Open Book
Tutorials	40 Min.	32		Open Book. There will be twelve tutorials. In each tutorial, a randomly and independently selected problem will be given for solving. One out of tutorials 1 to 3, one out of tutorials 4 to 6, one out of tutorials 7 to 9, and one out of tutorials 10 to 12 will be evaluated (each having 8% weightage). Each student can decide which tutorials to evaluate.

7. Chamber Consultation Hour:

Abhishek Mishra: 15:00 to 16:00 on Fridays (6121S).
Kamlesh Tiwari: 15:00 to 16:00 on Mondays / Fridays (6120N).

8. Notices: All notices will be posted on Nalanda.

9. Make-up Policy: Make-up exam may be arranged only in genuine cases with prior permission. No makeup for Tutorial test.

10. Note (if any): There is no makeup for tutorials. Students are not allowed to sit in different tutorial sections.

<u>11. Open Book Policy:</u> Only hard copies are allowed (lecture notes, text book, or reference books).

Abhishek Mishra

Instructor-in-charge
Course No. CS F364