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

SECOND SEMESTER 2022-23
REVISED COURSE HANDOUT

Date: 16.01.2023

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 (abhishek.mishra@pilani.bits-pilani.ac.in)**
Instructor(s) : **Pawan Kumar Mishra (pawan.mishra@pilani.bits-pilani.ac.in)**
Tutorial/Practical Instructors: Ravi Kant (p20190020@pilani.bits-pilani.ac.in) & Bhaskar Mangal (p20210473@pilani.bits-pilani.ac.in)

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 to Algorithms, Motivation, Problem Breakdown Strategies with Examples.
2	Examples Contd., Analysis of Algorithm, Inductive Programming (using Weak Induction).
3	Inductive Programming Contd.., Divide and Conquer Techniques – Philosophy of the paradigm with examples, Order Statistics-I.
4	Counting Inversions, Integer Multiplication.
5	Quick Select, Order Statistics-II.
6	Closest pair between points.
7	Greedy Techniques – Philosophy of the paradigm with examples, Vertex Cover on trees.
8	Independent Set on trees, Intervals Scheduling and its Variants.
9	Interval Scheduling contd., Fractional Knapsack, Correctness of Fractional Knapsack
10	Huffman Encoding, Optimality of Huffman Encoding.
11	Optimality of Huffman Encoding (Contd..), Coin Change Problem.
12	Dynamic Programming (DP) Techniques-Philosophy of the Paradigm with examples.
13	DP using low dimension tabulation, Weighted Interval Scheduling.
14	More examples using low dimension tabulation, DP using higher dimension tabulation.
15	0/1-Knapsack, Longest Common Subsequence.
16	Matrix Chain Multiplication.
17	Network Flow Techniques- Maximum Flow Problem and the Ford-Fulkerson Algorithm.
18	Maximum Flows and Minimum Cuts in a Network.

19	Applications of Max Flow Problem–The Bipartite Matching Problem.
20	Disjoint Paths in 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	15th March, 14:00 – 15:30	**Open Book**
Comprehensive Examination	3 H	44	13th May, 9:00 – 12:00	**Open Book**
Tutorials	40 Min.	28	Tuesdays, 16:00 to 16:40 (T2 and T4) and Fridays, 8:00 to 8:40 (T1 and T3).	**Close Book** There will be 12 tutorials. In each tutorial, a randomly 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 7% weightage). Each student can decide which tutorials to evaluate.

7. Chamber Consultation Hour:

Abhishek Mishra: 12:00 to 12:50 on Saturdays (6121-S)
(with prior appointment on email).
Pawan K. Mishra: 15:00 to 15:50 on Thursday (6120-N)
(with prior appointment on email).

8. Notices: All notices will be posted on

https://nalanda-aws.bits-pilani.ac.in.

9. Make-up Policy: Make-up exam may be arranged only in genuine cases with prior permission. **No makeup and no change of sections are allowed for the Tutorial tests.**

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

Abhishek Mishra

Instructor-in-charge
Course No. CS F364