Approved in 40th BoA Meeting (11-05-2021)

Course number : CS514

Course name : Data Structures and Algorithms-II

Credits : 3-0-2-4

Prerequisites : CS-202 (DSA) or equivalent for UG students, None for PG students

Intended for : BTech (Semester 5 or 6) who have not taken CS403, MTech (CSE), MS, PhD

Distribution : Discipline Core for MTech CSE, Elective for UG CSE/DS, MS/PhD

Semester : Odd/Even

1. Preamble

The proposed elective course, building on top of the course on Data Structures and Algorithms (CS202), offers formal introduction to various common algorithm design techniques, methods for analyzing the performance of corresponding algorithms and improving their efficiency, and to provide performance guarantees.

The theoretical aspects of this course are going to be supplemented by comprehensive practice exercises and weekly programming labs worth one lab credit.

2. Course modules

1. Review of Data Structures from CS202: Asymptotic Notations, Solving recurrences, Insertion Sort, Merge Sort, QuickSort (3 H)
2. Advanced topics in Sorting and Searching:- Randomized Data Structures Treaps, Hashing, AVL Trees, Bucket Sort. (6 H)
3. Dynamic Programming (3 H)
4. Amortized analysis: aggregate analysis, accounting, potential method (3 H)
5. Graph Algorithms: Single-Source Shortest Paths Bellman Ford, All-Pairs Shortest Paths using Floyd Warshall, Maximum Flow (Ford Fulkerson) (6 H)
6. Advanced Data Structures: Quake heaps, van Emde BoasTrees, Union Find Data structures (6 H)
7. Computational complexity: Problem classes: P, NP, NP-complete, NP-hard. Reduction. Cook's theorem. Examples of NP-complete problems. (6 H)
8. Approximation Algorithms:- Greedy and Local Search algorithms, DP Algorithms (3 H)

9. Parameterized Complexity:- Introduction to FPT, Bounded Search Trees, Kernels
10. Additional Topics:-
    Streaming Algorithms:- Misra Gries, Count–min sketch, LSH, lossy count algorithm (3 H)
    Comp. Geometry:- Convex Hull, Line segment intersection, Voronoi Diagrams (3 H)
11. Coding Lab which covers topics discussed in this course (28H)

3. Textbook

1) T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, Introduction to Algorithms, MIT Press, 3/e, 2009.
2) J. Kleinberg and E. Tardos, Algorithm Design, Pearson, 2006.

4. Reference books

1) S. Dasgupta, C. H. Papadimitriou, U. V. Vazirani, Algorithms, McGraw-Hill, 2006.
2) S. S. Skiena, The Algorithm Design Manual, Springer, 2/e, 2008

5. Similarity content declaration with existing courses:

	Course Name	**Common Topic(s)**	**Overlap (%)**
CS202	Data Structures and Algorithms	Hashing and Heap related concepts	Less than 10%
CS403	Advanced Data Structures & Algorithms	Several common topics	More than 30%

6. Justification of new course proposal if cumulative similarity content is >30%:

This course is proposed as a core course for MTech (CSE) and BTech students shall also be allowed to credit the same. The overwhelming overlap of contents (with CS403) is deliberate because we intend to discontinue offering CS403 starting from the winter session of 2021. Some parts of CS403 have either been covered in CS202 or are not relevant to the currently trending research areas. We compensate for these topics by adding new topics which we feel are best suited for the students and this upgrade in coursework also makes this course suitable for M.S., M.Tech and Ph.D. candidates.