University of Engineering and Management

Institute of Engineering & Management, Salt Lake Campus
Institute of Engineering & Management, New Town Campus
University of Engineering & Management, Jaipur

Syllabus for B.Tech Admission Batch 2022

Subject Name: Design & Analysis of Algorithm Credit: 3 Lecture Hours: 36
Subject Code: PCCCS404

Module number	Topic	Sub-topics	Mapping with Industry and International Academia	Lecture Hours	Corresponding Lab Assignment
1	Introduction to Algorithms	Characteristics of algorithm. Analysis of algorithm: Asymptotic analysis of complexity bounds – best, average and worst-case behaviour; Performance measurements of Algorithm, Time and space trade-offs, Analysis of recursive algorithms through recurrence relations: Substitution method,	***International Academia:*** (MIT Open Courseware): Overview, Interval Scheduling, Complexity: Approximation Algorithms, Fixed-parameter Algorithms, Cache-oblivious Algorithms: Medians & Matrices, Searching & Sorting https://ocw.mit.edu/courses/6-046j-design-and-analysis-of-algorithms-spring-2015/pages/lecture-notes/ ***AICTE-prescribed syllabus:*** https://www.aicte-india.org/sites/default/files/Mod	8	1. Given a sorted array and a number X, search two elements of the array such that their sum is X. Expected time complexity is O(n). 2. Given a sorted array and a number x, write a function that counts the occurrences of x in the array. Expected time complexity is O(logn). 3. Median of two sorted arrays: There are 2 sorted arrays A and B; each of size n. Write an algorithm to find the median of the array obtained after merging the above 2 arrays (i.e. array of length 2n). The complexity should be O(log(n)).

		Recursion tree method and Masters' theorem.	el_Curriculum/AICTE%20-%20UG%20CSE.pdf ***Industry Mapping:*** As per competitive coding standard of various industry. Also refer to laboratory exercises.		4. Given an array of digits, sort them with time complexity O(n).
2	Fundamental Algorithmic Strategies	Brute-Force, Divide and Conquer, Greedy, Dynamic Programming, Branch-and-Bound and Backtracking methodologies for the design of algorithms; Illustrations of these techniques for Problem-Solving , Bin Packing, Knap Sack TSP. Heuristics – characteristics and their application domains.	***International Academia:*** (MIT Open Courseware): Divide & Conquer: Convex Hull, Median Finding, FFT, Van Emde Boas Trees, Randomization: Matrix Multiply, Quicksort, Dynamic Programming: All-pairs Shortest Paths, Greedy Algorithms: Minimum Spanning Tree https://ocw.mit.edu/courses/6-046j-design-and-analysis-of-algorithms-spring-2015/pages/lecture-notes/ ***AICTE-prescribed syllabus:*** https://www.aicte-india.org/sites/default/files/Model_Curriculum/AICTE%20-%20UG%20CSE.pdf ***Industry Mapping:***	14	1. Implement Binary Search using Divide and Conquer. 2. Apply Binary Search on 2D NxM array (A) having numbers stored in non-decreasing order under row-major scanning. 3. A Bitonic Sequence is a sequence of numbers which is first strictly increasing then after a point strictly decreasing. A Bitonic Point is a point in the bitonic sequence before which elements are strictly increasing and after which elements are strictly decreasing. Find bitonic points in a bitonic sequence. 4. Apply Merge Sort to count inversion pairs in an array. Two elements a[i] and a[j] form an inversion pair if a[i] > a[j] and i < j. Example: The sequence 2, 4, 1, 3, 5 has three inversions (2, 1), (4, 1), (4, 3). 5. Implement a greedy algorithm to solve the fractional knapsack problem.

			As per competitive coding standard of various industry. Also refer to laboratory exercises.		6. Find the second largest and second smallest number simultaneously in an array using Divide & Conquer Principle. 7. Find neighbors of the median element in an array using the partitioning strategy of the Quick-Sorting method. 8. Given an array p[] which represents the chain of matrices such that the i-th matrix Ai is of dimension p[i-1] x p[i]. We need to write a function that should return the optimal parenthesizing expression resulting in a minimum multiplication cost to multiply the chain. 9. Given weights and values of n items, put these items in a knapsack of capacity W to get the maximum total value in the knapsack. You cannot break an item, either pick the item, or don’t pick it. 10. Implement the greedy algorithm to solve the problem of the Job Sequencing with deadlines. 11. Implement a greedy algorithm for finding the single-source shortest paths. Suggest an algorithm if the given graph contains negative weights and non-negative weight cycle and implement it.

					12. Apply Strassen’s Matrix Multiplication strategy for odd dimensional square matrices. 13. Given a cost 2D-matrix and a position (m, n), write a function that returns the minimum cost-path to reach (m, n) from (0, 0). 14. Given a value V and an infinite supply of coins of m-denominations {C1=1<C2<C3<..<Cm}, we want to make change for Rs. V. Apply DP strategy to find out the minimum number of coins to make the change? 15. Implement all pairs of the Shortest path algorithms for a graph using Floyd Warshall’s strategy.
3	Graph and Tree Algorithms	Traversal algorithms: Depth First Search (DFS) and Breadth First Search (BFS); Shortest path algorithms, Transitive closure, Minimum Spanning Tree, Topological sorting, Network Flow Algorithm.	***International Academia:*** (MIT Open Courseware): Minimum Spanning Tree, Synchronous Distributed Algorithms: Symmetry-breaking. Shortest-paths Spanning Trees, Baseball Elimination Notes https://ocw.mit.edu/courses/6-046j-design-and-analysis-of-algorithms-spring-2015/pages/lecture-notes/ ***AICTE-prescribed syllabus:***	8	1. Given a set of non-negative integers, and a value sum, determine if there is a subset of the given set with sum equal to given sum. 2. Implement DP strategy to solve the Traveling Salesman Problem (TSP). 3. Students need to develop a software or tool using any language for Plagiarism Checker. The primary objective of this project is that they have to implement a data structure concept and algorithm and show us how they implement it.

			https://www.aicte-india.org/sites/default/files/Model_Curriculum/AICTE%20-%20UG%20CSE.pdf ***Industry Mapping:*** As per competitive coding standard of various industry. Also refer to laboratory exercises.		4. Professor Sarkar thinks he has discovered a remarkable property of binary search trees. Suppose that the search for key k in a binary search tree ends up in a leaf. Consider three sets: A, the keys to the left of the search path; B, the keys on the search path; and C, the keys to the right of the search path. Professor Bunyan claims that any three keys a ∈ A, b ∈ B, and c ∈ C must satisfy a ≤ b ≤ c. Give a smallest possible counterexample to the professor's claim.
4	Tractable and Intractable Problems	Computability of Algorithms, Computability classes – P, NP, NP-complete and NP-hard. Cook's theorem, Standard NP-complete problems and Reduction techniques. Advanced Topics: Approximation algorithms, Randomized algorithms, Class of problems beyond NP – PSPACE.	***International Academia:*** (MIT Open Courseware): Linear Programming: LP, Reductions, Simplex, Complexity: P, NP, NP-completeness, Reductions, Randomization: Skip Lists, Universal & Perfect Hashing, Amortization: Amortized Analysis, Incremental Improvement: Matching, Cryptography: Hash Functions, Encryption https://ocw.mit.edu/courses/6-046j-design-and-analysis-of-algorithms-spring-2015/pages/lecture-notes/ ***AICTE-prescribed syllabus:*** https://www.aicte-india.org/sites/default/files/Mod	6	1. KMP String Matching: Given a text txt[0..n-1] and a pattern pat[0..m-1], write a function search(char pat[], char txt[]) that prints all occurrences of pat[] in txt[]. You may assume that n > m. Text: A A B A A C A A D A A B A A B A Pattern: A A B A 2. Implement a routine management system that will work for the next semester.

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