Marwadi University
Faculty of Engineering and Technology
Department of Information and Communication Technology

Subject Code: 01CT0512

Subject Name: Design and Analysis of Algorithm

B. Tech. Year – III (Semester V)

Objectives: Obtaining efficient algorithms is very important in modern computer engineering as the world wants applications to be time and space and energy efficient. This course enables to understand and analyze efficient algorithms for various applications.

Credits Earned: 04 Credits

Course Outcomes: After completion of this course, student will be able to:

1. Compare various algorithm design techniques for developing algorithms by evaluating the asymptotic complexities and time-space trade-off. (Understand)
2. Develop different algorithms using various methods like dynamic and Greedy methods. (Apply)
3. Select appropriate pattern matching algorithm to develop model for substring, subsequence, DNA matching, etc. (Apply)
4. Distinguish between Polynomial, Non-Polynomial complete and Hard problems (Analyse)
5. Evaluate various graph algorithms for sparse and dense network structures (Evaluate)

Pre-requisite of course: Proficiency in any programming language, Data Structures, Discrete Mathematics.

Teaching and Examination Scheme:

Teaching Scheme (Hours)			Credits	Theory Marks			Tutorial / Practical Marks		Total Marks
				E	I		V	T	
Theory	Tutorial	Practical		ESE	IA	CSE	Viva	Term Work	
3	0	2	4	50	30	20	25	25	150

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Content:

Unit	Topics	Content Hours
1	**Introduction to Design and Analysis of Algorithms:** What is an algorithm, Mathematics for Algorithmic Sets, Functions and Relations, Vectors and Matrices, Linear Inequalities and Linear Equations.	2
2	**Asymptotic Analysis of Algorithm:** The efficient algorithm, Average, Best- and worst-case analysis, Amortized analysis, Asymptotic Notations (Big Oh, Big Theta, Big Omega), Master Method, Sorting Algorithms and their analysis, Sorting in linear time: Bucket sort, Radix sort and Counting sort	06
3	**Divide and Conquer** Introduction, Recurrence and different methods to solve recurrence, multiplying large Integers Problem, Problem Solving using divide and conquer algorithm - Binary Search, Max-Min problem, Sorting (Merge Sort, Quick Sort), Matrix Multiplication, Exponential	06
4	**Dynamic Programming:** Introduction, Elements of Dynamic Programming, The Principle of Optimality, Problem Solving using Dynamic Programming – Calculating the Binomial Coefficient, Making Change Problem, Assembly Line-Scheduling, Knapsack problem, Matrix chain multiplication, Longest Common Subsequence	06
5	**Greedy Algorithm** General Characteristics of greedy algorithms, Elements of greedy strategy, Problem solving using - Activity selection problem, Fractional Knapsack Problem, Job Scheduling Problem.	04
6	**Graph Algorithms** Representation of Undirected & Directed Graph, Traversing Graphs, Depth FirstSearch, Breath First Search, Topological sort, Strongly Connected components. Single pair shortest path and Minimum Spanning trees (Kruskal's algorithm, Prim's algorithm) using greedy approach, All Points Shortest path using DynamicProgramming	06
7	**Backtracking and Branch and Bound:** Introduction, The Eight queens' problem, Knapsack problem, Travelling Salesman problem, Minmax principle	04
8	**String Matching:** Introduction, The naive string-matching algorithm, The Rabin-Karp algorithm, String Matching with finite automata	04
9	**Introduction to NP-Completeness:** The class P and NP, Polynomial reduction, 2-CNF Satisfiability, -CNF Satisfiability, NP- Completeness Problem, NP-Hard Problems. Travelling Salesman problem, Hamiltonian problem	04
	Total Hours	**42**

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Suggested Text books / Reference books:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, forth edition, The MIT Press
2. Gills Brassard and Paul Bratley, Fundamental of Algorithmics, first edition, Prentice-Hall International
3. Introduction to Design and Analysis of Algorithms, Anany Levitin, third edition (2021), Pearson.
4. Design and Analysis of Algorithms, Dave and Dave, first edition (2007), Pearson.

Suggested Theory distribution:

The suggested theory distribution as per Bloom's taxonomy is as per follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process.

Distribution of Theory for course delivery and evaluation					
Remember	Understand	Apply	Analyze	Evaluate	Create
10%	10%	40%	20%	10%	10%

Suggested List of Experiments:

1. Implementation and Time analysis of sorting algorithms
2. Bubble sort, Selection sort, Insertion sort, Merge sort and Quicksort
3. Implementation and Time analysis of linear and binary search algorithm.
4. Implementation of max-heap sort algorithm
5. Implementation and Time analysis of factorial program using iterative and recursive method
6. Implementation of a knapsack problem using dynamic programming.
7. Implementation of chain matrix multiplication using dynamic programming.
8. Implementation of making a change problem using dynamic programming
9. Implementation of a knapsack problem using greedy algorithm
10. Implementation of Graph and Searching (DFS and BFS).
11. Implement prim's algorithm.
12. Implement Kruskal's algorithm.
13. Implement LCS problem.
14. To implement following string-matching algorithms and analyze time complexities: a. Naïve b. Rabin Karp c. Knuth Morris Pratt
15. Write a program for Floyd-Warshal algorithm.
16. Write a program for travelling salesman problem.
17. Write a program for Hamiltonian cycle problem.
18. To implement Huffman coding and analyze its time complexity.
19. Write a program for Strassen's Matrix Multiplication.

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Instructional Method:

1. The course delivery method will depend upon the requirement of content and need of students. Theteacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.
2. The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.
3. Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.
4. Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory

Supplementary Resources:

1. http://www.personal.kent.edu/~rmuhamma/Algorithms/algorithm.html
2. http://nptel.ac.in/courses/106101060/
3. http://www.comp.nus.edu.sg/~cs5234/Links/Course-Links.htm
4. https://www.coursera.org/learn/algorithm-design-analysis
5. http://www.codeskulptor.org/docs.htmlhttp://www.geeksforgeeks.org
6. http://www.algolist.net
7. http://www.cprogramming.com
8. http://www.codingunit.com