



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Subject Code: BE05016011

Subject Name: Algorithm Analysis and Design

w.e.f. Academic Year:	2024 - 25
Semester:	5
Categor of the Course:	Professional Core Course

<b>Prerequisite:</b>	Basic understanding of computer and programming
<b>Rationale:</b>	Designing efficient algorithms is a fundamental aspect of modern computer engineering, especially as today's applications increasingly require high performance with minimal use of time, memory, and energy. This course helps students build a clear understanding of how to develop, analyze, and apply efficient algorithms across a variety of real-world problems.

**Course Outcome:**

After Completion of the Course, Student will be able to:

No	Course Outcomes	RBT Level
01	Identify Time and Space complexities of various algorithms	RM
02	Solve and analyze the problems divide and conquer methods	UN
03	Solve and analyze the problems using greedy and dynamic programming	AP
04	Understand and solve graph based problems	CR
05	Apply backtracking and branch and bound methods to solve various problems	EL

*\*Revised Bloom's Taxonomy(RBT)*

**Teaching and Examination Scheme:**

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
L	T	P	PBL*	TH		Theory		Tutorial / Practical			
						ESE (E)	PA (M)	PA (I)	PBL (I)	ESE (V)	
45	0	30	45	120	04	70	30	20	30	50	200

\* Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.



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## Course Content:

Unit No.	Content	No. of Hours
1	<b>Introduction and Analysis of Algorithm:</b> What is an algorithm?, Properties of good algorithm, Mathematics for Algorithmic Sets, Functions and Relations, Vectors and Matrices, Linear Inequalities and Linear Equations, The efficient algorithm, Average, Best and worst case analysis, Amortized analysis, Asymptotic Notations (Big Oh, Big Theta, Big Omega), Analyzing control statement, Loop invariant and the correctness of the algorithm, Disjoint set operations, Union and find algorithms	6
2.	Analysis of Sorting Algorithms: Comparison based sorting: Bubble sort, Selection sort, Insertion sort, Heap sort, Sorting in linear time: Bucket sort, Radix sort and Counting sort	6
3.	Divide and Conquer: Introduction, General method, Recurrence and different methods to solve recurrence, Problem solving using Divide and Conquer: Binomial Coefficient, Binary Search, Max-Min problem, Merge Sort, Quick Sort, Strassen's algorithm for Matrix Multiplication, Exponential.	6
4.	Dynamic Programming: Introduction, General method, Elements of Dynamic Programming, The Principle of Optimality Problem Solving using Dynamic Programming: Making Change Problem, Knapsack problem, Multi stage graph, Matrix chain multiplication, Longest Common Subsequence, Shortest Common Super sequence	6
5.	Greedy Algorithm: Introduction, General method, Characteristics of greedy algorithms, Elements of greedy strategy Problem solving using Greedy method: Making change problem, Activity selection problem, Knapsack problem (0/1 and Fractional), Job Scheduling Problem, Huffman Trees	5
6.	Graph Algorithms: Introduction, Types of graph, Representation Graph, Traversing Graphs: Depth First Search, and Breath First Search, Topological sort, Strongly Connected components. Problems solving: Finding articulation point, Minimum Spanning trees (Kruskal's algorithm, Prim's algorithm) using greedy approach, Dijkstra's Algorithm, Single pair shortest path using greedy method, All Points Shortest path using Dynamic Programming,	7
7.	Backtracking: Introduction, General method, n-queen problem, Sum of subset problem, Graph coloring problem, Hamiltonian cycle problem, Branch and Bound: General method, LC branch and bound, FIFO branch and bound, Traveling salesman problem	6
8.	Introduction to NP-Completeness: The class P and NP, Polynomial reduction, NP-Complete Problems, NP-Hard Problems. Approximation Algorithm: TSP Randomized Algorithm: Quick sort	3

## Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in%)					
RLevel	ULevel	ALevel	NLevel	E Level	CLevel
20	20	15	15	15	15

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)



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## References/Suggested Learning Resources:

### (a) Books:

1. Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, PHI.
2. Introduction to Design and Analysis of Algorithms, Anany Levitin, Pearson.
3. Fundamental of Algorithms by Gills Brassard, Paul Bratley, PHI.
4. Foundations of Algorithms, Shailesh R Sathe, Penram

### (b) Open source software and website:

### NPTEL Course:

1. Introduction to Algorithms and Analysis By Prof. Sourva Mukhopadhyay | IIT Kharagpur
2. Design and Analysis of Algorithms By Prof. Madhvan Mukund | Chennai Mathematical Institute
3. Fundamental Algorithms By Prof. Sourva Mukhopadhyay | IIT Kharagpur

### Suggested Course Practical List:(List can be change according to Latest Development)

1. Perform following sorting operation and measure the execution time for sufficient large input: Selection Sort, Bubble Sort, Insertion Sort
2. Implement Linear search and Binary Search
3. Perform following sorting operation and measure the execution time for sufficient large input: Merge Sort, Quick Sort
4. Solve Given Problems using Greedy Strategy: Make a change problem, Activity Selection
5. Solve Given Problems using Greedy Strategy: Problem, 0/1 Knapsack Problem, Job Scheduling Problem
6. Solve Given Problems using Greedy Strategy: MST using Prim's Algorithm, MST using Krushkal's Algorithm
7. Solve Given Problems Using Dynamic Programming: Multistage graph, 0/1 Knapsack Problem
8. Solve Given Problems Using Dynamic Programming: Matrix Chain Multiplication
9. Solve Given Problems Using Dynamic Programming: Longest Common Subsequence (LCS), Shortest Common Supper sequence (SCS)
10. Solve following problems using Backtracking 4-Queen Problem, 8-Queen Problem

### List of suggested activities for Problem Based Learning:

Sl. No	Name of the activity	No. of hours	Evaluation Criteria
1	Seminar / Presentation	Duration for study and preparation=10h Report writing=3h Presentation=2h Total=15h	Topic can be selected technical content beyond syllabus
2	Poster/chart/power point preparation on technical topics	Duration = 15h	Based on poster/chart preparation and presentation skills
3	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 10h Total = 15h	Based on in-depth study, technical depth, data collected, fact finding, etc.



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4	Self-learning on-line course	Minimum duration of the course should be 15h.	Examination based assessment at the end of course. Based on the certificate produced.
5	Application/Software development (Mini Project)	Duration = 15 h	Depending on the complexity of the Application/Software
6	Technical Video based learning related to the subject	Duration of video = 5h Report preparation & Presentation = 10h Total = 15h	Report /presentation based on the video learning outcomes.

Note:

- All the suggested activity should be related to the subject.
- Min 1 activities must be carried out as per the availability of faculties and students.
- The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
- Rubrics for the evaluation can be prepared by the faculty.
- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.

Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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