GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Subject Code: BE04000241
Subject Name: Analysis and Design of Algorithms

WEF Academic Year	2024-25
Semester	4
Category of the Course	PCC

Prerequisite :	Data Structure, Programming
Rationale :	Developing efficient algorithms is crucial in modern computer engineering, as today's applications demand optimized performance in terms of time, space, and energy. This course provides the knowledge and skills to understand and analyze efficient algorithms for a wide range of applications.

Course Outcome :

After Completion of the Course, Student will 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

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Course Scheme :

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		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.**

Course Content:

Sr. No.	Course Content	No. of Hours	% of Weightage
1	**Introduction and Analysis of Algorithm:** Introduction to algorithm, Properties of good algorithm**,** Average, Best and worst case analysis, Asymptotic Notations (Big Oh, Big Theta, Big Omega), Disjoint set operations, Union and find algorithms,	4	10
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	15
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, Quick sort using median of three, Matrix Multiplication, Exponential.	6	15
4	**Dynamic Programming:** Introduction, General method, Elements of Dynamic Programming, The Principle of Optimality Problem Solving using Dynamic Programming: Binomial Coefficient, Making Change Problem, Knapsack problem, Matrix chain multiplication, Longest Common Subsequence, Shortest Common Supersequence	6	15
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,	5	10
6	**Graph Algorithms:** Introduction, Types of graph, Representation Graph, Traversing Graphs: Depth First Search, and Breath First Search, Topological sort, Strongly Connected components.	6	15

	Problems solving: Finding articulation point, Minimum Spanning trees (Kruskal's algorithm, Prim's algorithm) using greedy approach, Single pair shortest path using greedy method, All Points Shortest path using Dynamic Programming,		
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, Knapsack problem	6	15
8	**Introduction to NP-Completeness:** The class P and NP, Polynomial reduction, NP- Complete Problems, NP-Hard Problems.	3	05
	Total	**42**	**100**

Reference Book :

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

Suggested Course Practical List:

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: Make a change problem, 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 Laboratory/Learning Resources Required:

- https://codecrucks.com/what-is-algorithm-nutshell-explanation/
- https://www.datacamp.com/blog/what-is-an-algorithm
- https://khyatirnirmal.wordpress.com/design-analysis-and-algorithm/
- https://elogeel.wordpress.com/category/algorithms-design-and-analysis/

- **List of suggested activities for Problem Based Learning:**

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1	Assignment writing. Numerical based assignment is preferable.	5 assignments of 3h each. Total = 15h	Based on the assignment submitted.
2	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding-based problems of 3h each. Total = 15h	Based on the coding solution submitted.
3	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.
4	Discussion on research paper based on relevant subject	3 research paper = 15h	Summarize research paper and evaluation critical parameters
5	Poster/chart/power point preparation on technical topics	Duration = 10 h	Based on poster/chart preparation and presentation skills
6	Application/Software development	Duration = 15 h	Depending on the complexity of the Application/Software
7	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.
8	Seminar / Presentation	Duration for study and preparation=5h Report	Topic can be selected technical content beyond syllabus

		writing=3h Presentation=2h Total=10h	
9	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.
10	Working/non-working model on technical topics	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
11	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.
12	Complex problem solving	Maximum 3 problem. Study of the problem and solution finding, Total = 15h	Based on the depth of the solution submitted.
13	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
14	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
15	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment /health/any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions

Note:

- All the suggested activity should be related to the subject.
- Min 3 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.

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