Teaching Scheme and Syllabus

For

Bachelor of Technology

In

Any Discipline except CSE

Minor in Computer Science and Engineering

Department of Computer Science and Engineering

Sardar Vallabhbhai National Institute of Technology

B.Tech. Minor in Computer Science and Engineering

Curriculum

Sr. No.	Semester	Subject Name	Code	Scheme	Credits
1	IV	Data Structures	CS M01	3-0-2	4
2	V	Design And Analysis of Algorithms	CS M02	3-1-0	4
3	VI	Data Science	CS M03	3-1-0	4
4	VII	Artificial Intelligence	CS M04	3-0-2	4
5	VII	Mini Project	CS M05	0-0-8	4

Pre-requisite for admission to B.Tech. Minor in CSE Program: Knowledge of C Programming gained through relevant course in B.Tech. I or through NPTEL/SWAYAM/any other portals.

Total Seats: 15

B.Tech. (Minor in CSE) Semester – IV DATA STRUCTURES CS M01	Scheme	L	T	P	Credit
		3	0	2	04

1.	Course Outcomes (COs): At the end of the course, the students will be able to
CO1	recognize the need of different data structures and understand its characteristics.
CO2	apply different data structures for given problems.
CO3	design and analyse different data structures, sorting and searching techniques.
CO4	evaluate data structure operations theoretically and experimentally.
CO5	give solutions for complex engineering problems.

2.	Syllabus	
	INTRODUCTION TO DATA STRUCTURES	**(03 Hours)**
	Review of Concepts: Information and Meaning, Abstract Data Types, Internal Representation of Primitive Data Structures, Arrays, Strings, Structures, Pointers.	
	LINEAR LISTS	**(06 Hours)**
	Sequential and Linked Representations of Linear Lists, Comparison of Insertion, Deletion and Search Operations for Sequential and Linked Lists, Doubly Linked Lists, Circular Lists, Lists in Standard Template Library (STL), Applications of Lists.	
	STACKS	**(06Hours)**
	Sequential and Linked Implementations, Representative Applications such as Recursion, Expression Evaluation Viz., Infix, Prefix and Postfix, Parenthesis Matching, Towers of Hanoi, Wire Routing in a Circuit, Finding Path in a Maze.	
	QUEUES	**(06 Hours)**
	Operations of Queues, Circular Queue, Priority Queue, Dequeue, Applications of Queues, Simulation of Time Sharing Operating Systems, Continuous Network Monitoring System Etc.	
	SORTING AND SEARCHING	**(04 Hours)**
	Sorting Methods, Bubble Sort, Selection Sort, Quick Sort, Radix Sort, Bucket Sort, Dictionaries, Hashing, Analysis of Collision Resolution Techniques, Searching Methods, Linear Search, Binary Search, Character Strings and Different String Operations.	
	TREES	**(08 Hours)**

	Binary Trees and Their Properties, Terminology, Sequential and Linked Implementations, Tree Traversal Methods and Algorithms, Complete Binary Trees, General Trees, AVL Trees, Threaded Trees, Arithmetic Expression Evaluation, Infix-Prefix-Postfix Notation Conversion, Heaps as Priority Queues, Heap Implementation, Insertion and Deletion Operations, Heapsort, Heaps in Huffman Coding, Tournament Trees, Bin Packing.	
	MULTIWAY TREES	**(05 Hours)**
	Issues in Large Dictionaries, M-Way Search Trees, BTrees, Search, Insert and Delete Operations, Height of B-Tree, 2-3 Trees, Sets and Multisets in STL.	
	GRAPHS	**(07 Hours)**
	Definition, Terminology, Directed and Undirected Graphs, Properties, Connectivity in Graphs, Applications, Adjacency Matrix and Linked Adjacency Chains, Graph Traversal, Breadth First and Depth First Traversal, Spanning Trees, Shortest Path and Transitive Closure, Activity Networks, Topological Sort and Critical Paths.	
	Practicals will be based on the coverage of the above topics separately	**(30 Hours)**
	(Total Contact Time: 45 Hours + 30 Hours = 75 Hours)	

3.	**Practicals**
1	Implementation of Array and its applications
2	Implementation of Stack and its applications
3	Implementation of Queue and its applications
4	Implementation of Link List and its applications
5	Implementation of Trees and its applications
6	Implementation of Graph and its applications
7	Implementation of Hashing functions and collision resolution techniques
8	Mini Project (Implementation using above Data Structure)

4.	**Books Recommended**
1	Trembley & Sorenson: "An Introduction to Data Structures with Applications", 2/E, TMH, 1991.
2	Tanenbaum & Augenstein: "Data Structures using C and C++", 2/E, Pearson, 2007.
3	Horowitz and Sahani: "Fundamentals of Data Structures in C", 2/E, Silicon Press, 2007.

4	T. H. Cormen, C. E. Leiserson, R. L. Rivest: "Introduction to Algorithms",3/E, MIT Press, 2009.
5	Robert L. Kruse, C. L. Tondo and Brence Leung: "Data Structures and Program Design in C", 2/E, Pearson Education, 2001.

B.Tech. (Minor in CSE) Semester – V DESIGN AND ANALYSIS OF ALGORITHMS CS M02	Scheme	L	T	P	Credit
		3	1	0	04

1.	Course Outcomes (COs): At the end of the course, students will be able to
CO1	Acquire knowledge about the application of mathematical formula and technique to solve the problem and computational complexity analysis.
CO2	Apply the different algorithm design techniques for designing a solution of different applications.
CO3	Analyse the performance of algorithms using different algorithmic design techniques based on asymptotic or amortized or probabilistic methods.
CO4	Evaluate the correctness and implementation of algorithms using different methods of performance evaluation.
CO5	Design and innovate efficient algorithms in the field of computer science & engineering and industry related applications using the different algorithm design techniques.

2.	Syllabus	
	INTRODUCTION	**(05 Hours)**
	Introduction to Algorithms, Analysis and Design Techniques, Analysis Techniques: Mathematical, Empirical and Asymptotic Analysis. Recurrence Relations and Solving Recurrences, Mathematical Proof Techniques, Amortized Analysis, Probabilistic Analysis.	
	DIVIDE AND CONQUER APPROACH	**(08 Hours)**
	Sorting & Order Statistics, Divide and Conquer Technique, Various Comparison based Sorts, Analysis of the Worst-Case and the Best-Cases, Randomized Sorting Algorithms, Lower Bound on Sorting, Non-comparison based Sorts, Medians and Order Statistics, Min-Max Problem, Polynomial Multiplication, Fast Fourier Transform.	
	GREEDY DESIGN TECHNIQUES	**(08 Hours)**
	Basic Greedy Control Abstraction, Motivation, Thirsty Baby Problem, Formalization, Activity Selection and its Variants, Huffman Coding, Horn Formulas, Tape Storage Problem, Container Loading Problem, Knapsack Problem, Graph Algorithms, Graph algorithms: All-pairs Shortest Paths, Topological Ordering of DAG, DFS in Directed Graphs, Strongly Connected Components, Minimum Spanning Trees, Single Source Shortest Paths, Maximum Bipartite Cover Problem, Network Flows: Ford Fulkerson Algorithm, Max-flow Min-cut Theorem, Polynomial Time Algorithms for Max-flow.	
	DYNAMIC PROGRAMMING	**(08 Hours)**
	Motivation, Matrix Multiplication Problem, Assembly Line Problem, Coin Changing Problem, Longest Common Subsequence, 0/1 Knapsack problem, All-pairs Shortest	

	Path Problems, Dynamic Programming Control Abstraction, Optimal Binary Search Tree.	
	SEARCHING ALGORITHMS	**(04 Hours)**
	Backtracking, N-Queens Problem, Sum of Subset Problem, Complexity Analysis, Branch & Bound, Least Cost Branch & Bound (LCBB), LCBB Complexity Analysis, 15-Puzzle Problem, Traveling Sales Person Problem.	
	NUMBER THEORETIC ALGORITHMS	**(06 Hours)**
	Number Theoretic Notions, GCD, Modular Arithmetic, Chinese Remainder Theorem, Generators, Cyclic Groups, Galois Fields, Applications in Cryptography, Primality Testing.	
	NP-COMPLETE PROBLEMS	**(06 Hours)**
	Polynomial Time, Verification, NP-completeness, Search Problems, Reductions, Dealing with NPCompleteness, Approximation Algorithms, Local Search Heuristics.	
	Tutorials will be based on the coverage of the above topics.	**(15 Hours)**
	(Total Contact Time: 45 Hours + 15 Hours = 60 Hours)	

3.	**Books Recommended**
1	Cormen, Leiserson, Rivest, Stein," Introduction to Algorithms", 4/E, MIT Press, 2022.
2	J. Kleinberg, E. Tardos, "Algorithm Design", 1/E, Pearson Education, Reprint 2006.
3	Sartaj Sahni, "Data Structures, Algorithms and Applications in C++", 2/E, Universities Press/Orient Longman, 2005.
4	Sara Baase, Allen van Gelder," Computer Algorithms: Introduction to Design & Analysis, 3/E, Pearson Education, 2000.
5	Knuth, Donald E., "The Art of Computer Programming, Vol I &III", 3/E, Pearson Education, 1997.

B.Tech. (Minor in CSE) Semester – VI DATA SCIENCE CS M03	Scheme	L	T	P	Credit
		3	0	2	04

1.	Course Outcomes (COs): At the end of the course, the students will be able to
CO1	Understand types of data and various data science approaches.
CO2	Apply various data pre-processing and manipulation techniques including various distributed analysis paradigm using hadoop and other tools and perform advance statistical analysis to solve complex and large dataset problems.
CO3	Analyze different large data like text data, stream data, graph data.
CO4	Interpret and evaluate various large datasets by applying Data Mining techniques like clustering, filtering, factorization.
CO5	Design the solution for the real life applications.

2.	Syllabus	
	INTRODUCTION	**(03 Hours)**
	Examples, Applications and Results Obtained Using Data Science Techniques, Overview of the Data Science Process.	
	MANAGING LARGESCALE DATA	**(04 Hours)**
	Types of Data and Data Representations, Acquire Data (E.G., Crawling), Process and Parse Data, Data Manipulation, Data Wrangling and Data Cleaning.	
	PARADIGMS FOR DATA MANIPULATION, LARGE SCALE DATA SET	**(08 Hours)**
	Map reduce (Hadoop), Query Large Data Sets in Near Real Time with Pig and Hive, Moving from Traditional Warehouses to Map Reduce, Distributed Databases, Distributed Hash Tables.	
	TEXT ANALYSIS	**(10 Hours)**
	Data Flattening, Filtering and Chunking, Feature Scaling, Dimensionality Reduction, Nonlinear Factorization, Shingling of Documents, Locality Sensitive Hashing for Documents, Distance Measures, LSH Families for Other Distance Measures, Collaborative Filtering.	
	MINING DATA STREAM	**(08 Hours)**
	Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Moments, Windows, Clustering for Streams.	
	ADVANCED DATA ANALYSIS	**(12 Hours)**
	Graph Visualization, Data Summaries, Hypothesis Testing, ML Model-Checking and Comparison, Link Analysis, Mining of Graph, Frequent Item Sets Analysis, High Dimensional Clustering, Hierarchical Clustering, Recommendation Systems.	

	Practicals will be based on the coverage of the above topics separately.	**(30 Hours)**
	(Total Contact Time: 45 Hours + 30 Hours = 75 Hours)	

4.	**Books Recommended**
1	Tom White, “Hadoop: The Definitive Guide”, 4th Edition, O’reilly Media, 2015, ISBN: 9781491901687.
2	Anand Rajaraman and Jeffrey David Ullman, “Mining of Massive Datasets”, 2nd Edition, Cambridge University Press, 2014, ISBN: 9781107077232.
3	Peter Bruce, Andrew Bruce, “Practical Statistics for Data Scientists: 50” by , 2nd Edition, O’reilly publishing house, 2022, ISBN: 9781492072942.
4	Joel Grus, J. “Data science from scratch”, 1st Edition, O'Reilly Media, 2015, ISBN: 9781491901410.
5	Montgomery, Douglas C., and George C. Runger. “Applied statistics and probability for engineers”, John Wiley & Sons, 7th Edition, 2018, ISBN: 9781119400363.

B.Tech. (Minor in CSE) Semester – VII ARTIFICIAL INTELLIGENCE CS M04	Scheme	L	T	P	Credit
		3	0	2	04

1.	Course Outcomes (COs): At the end of the course, students will be able to
CO1	Understand the role of agents and how it is related to environment and the way of evaluating it and how agents can act by establishing goals
CO2	Apply various knowledge representation technique, searching techniques, constraint satisfaction problem and example problems- game playing techniques.
CO3	Analyse the current scope, potential, limitations, and implications of intelligent systems.
CO4	Evaluate the AI techniques suitable for recent areas of applications like expert systems, neural networks, fuzzy logic, robotics, natural language processing, and computer vision.
CO5	Create AI based solutions for complex engineering problems.

2.	Syllabus	
	INTRODUCTION	**(04 Hours)**
	Turing Test, Foundation and History of Artificial intelligence (AI), Possible Approaches in AI, Application Domains and Modern AI, Risk and benefits of AI.Intelligent Agents: Agent and Environment, Rationality, Rational Agent, Nature of Environment, PEAS, Structure of Agents, Complex Problems and AI, Problem Representation in AI.	
	PROBLEM SOLVING BY SEARCHING	**(12 Hours)**
	Problem solving agents, Search algorithms, Uninformed Search, Breadth first search, uniform cost search, depth first search, depth limited and iterative deepening search, Informed (Heuristic) Search, greedy best first search, A* and its varients, Heuristic function, Search in complex environment. Local Search and optimization problems, hill climbing search, simulated aneling, local beam search, Evolutionary algorithms, Genetic Algorithm, Local search in continuous space and nondeterministic actions, Constraint Satisfaction Problems, Constraint propagation.	
	ADVERSARIAL SEARCH AND GAMES	**(04 Hours)**
	Game theory, game tree, optimal decision in games, Minimax search, multiplayer, alpha-Beta, Expectimax, Monte Carlo tree search, stochastic games.	
	KNOWLEDGE REPRESENTION	**(04 Hours)**
	Logical agent, Knowledge based agent, representing simple facts in Logic, Propositional logic, First order logic, Predicate Logic, Inference in first order logic, Forward & Backward Chaining, unification, Inferencing By Resolution Refutation.	

	UNCERTAINTY KNOWLEDGE AND REASONING	**(08 Hours)**
	Quantifying Uncertainty, Basic Probability notation, Independence, Bayes Rule and its uses, Probabilistic reasoning, Bayesian Network, Fuzzy Logic, Probabilistic reasoning over time, Hidden Markov models, Kalman filters, Making simple decision, Decisions Theory, Utility Function, Decision Network, Algorithms for Markov Decision Process, Multiagent decision making cooperative and non-cooperative game theory.	
	LEARNING AGENTS	**(05 Hours)**
	Learning Agent, Types of learning, Learning from experience: Reinforcement Learning (RL), Rewards, policy, Model based and Model free learning, Temporal difference learning (TD-Learning) and Q Learning, RL Applications, Learning from Example: Supervised learning Introduction, Perceptron, Introduction to Neural Network and Deep Learning.	
	AI APPLICATIONS AND ETHICS	**(08 Hours)**
	Algorithms for Classing planning, Motion planning and navigation Natural language understanding, Computer Vision, AI in Healthcare, Philosophy, Ethics and safety of AI, Advance topics in AI	
	Practicals will be based on the coverage of the above topics separately.	**(30 Hours)**
	(Total Contact Time: 45 Hours + 30 Hours = 75 Hours)	

3.	**Practicals**
1	Introduction to Prolog programming
2	Types of agents and Problem Representation in AI
3	Searching in graph based problem space, exploring Uninformed search Techniques
4	Exploring Informed search Techniques (Vacuum world and Maze Problem)
5	Exploring Uninformed and Informed search Techniques (PACMAN Search Space)
6	Multi agent in a search space
7	Introduction Logical Agent and Knowledge representation using Prolog
8	Reasoning Under Uncertainty using Bayesian Learning
9	Reinforcement Learning using Q-Learning
10	Introduction to Machine Learning and Python libraries for Data Analysis (Pandas, NumPy, Matplotlib)

4.	**Books Recommended**
1	Stuart Russell, Peter Norvig, Artificial intelligence : A Modern Approach, Prentice Hall, Fourth edition, 2020.

2	Elaine Rich, Kevin Knight, and Shivashankar B Nair, Artificial Intelligence, McGraw Hill, 3rd ed., 2009.
3	Nils J. Nilsson, Artificial Intelligence: A New Synthesis, Morgan-Kaufmann, 1998.
4	Judea Pearl, Heuristics: Intelligent Search Strategies for Computer Problem Solving, Addison-Wesley Publishing Company, 1984.