



# MARRI LAXMAN REDDY

## INSTITUTE OF TECHNOLOGY AND MANAGEMENT

(AN AUTONOMOUS INSTITUTION)

(Approved by AICTE, New Delhi & Affiliated to JNTUH, Hyderabad)

Accredited by NAAC with 'A' Grade & Recognized Under Section 2(f) & 12(B) of the UGC act, 1956

### COURSE CONTENT

<b>ADVANCED ALGORITHMS</b>								
<b>II Semester: CSE</b>								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
2225804	Foundation	L	T	P	C	CIA	SEE	Total
		3	0	0	3	40	60	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil			Total Classes: 45			
<b>Prerequisites:</b> UG level course in Algorithm Design and Analysis								

#### Course Overview:

This course explores advanced algorithmic design techniques including divide-and-conquer, dynamic programming, greedy methods, and randomized algorithms. It covers graph algorithms, network flows, string matching, and computational geometry with rigorous complexity analysis

#### Course Objectives:

1. Introduce students to the advanced methods of designing and analyzing algorithms.
2. The student should be able to choose appropriate algorithms and use it for a specific problem.
3. To familiarize students with basic paradigms and data structures used to solve advanced algorithmic problems.
4. Students should be able to understand different classes of problems concerning their computation difficulties.
5. To introduce the students to recent developments in the area of algorithmic design.

#### Course Outcomes: After Completion of the Course, Students should be able to

1. Apply suitable sorting and graph traversal algorithms to solve computational problems.
2. Compare the correctness and efficiency of greedy algorithms for matroids and augmenting path-based algorithms.
3. Analyse the correctness of the Maxflow–Mincut theorem and flow algorithms, and examine the computational complexity of matrix operations under the divide-and-conquer paradigm.
4. Apply dynamic programming techniques such as the Floyd–Warshall algorithm to solve shortest path problems, and use modular arithmetic for computational problem solving.
5. Evaluate the efficiency and scalability of recently proposed searching and sorting techniques, as well as modern data structures, when applied to large-scale computational problems.

## **UNIT - I:**

### **Sorting:**

Review of various sorting algorithms, topological sorting

### **Graph:**

Definitions and Elementary Algorithms: Shortest path by BFS, shortest path in edge-weighted case (Dijkstra's), depth-first search and computation of strongly connected components, emphasis on correctness proof of the algorithm and time/space analysis, example of amortized analysis.

## **UNIT - II:**

### **Matroids:**

Introduction to greedy paradigm, algorithm to compute a maximum weight maximal independent set. Application to MST.

### **Graph Matching:**

Algorithm to compute maximum matching. Characterization of maximum matching by augmenting paths, Edmond's Blossom algorithm to compute augmenting path.

## **UNIT - III:**

### **Flow-Networks:**

Maxflow-mincut theorem, Ford-Fulkerson Method to compute maximum flow, Edmond-Karp maximum-flow algorithm.

### **Matrix Computations:**

Strassen's algorithm and introduction to divide and conquer paradigm, inverse of a triangular matrix, relation between the time complexities of basic matrix operations, LUP-decomposition.

## **UNIT - IV:**

### **Shortest Path in Graphs:**

Floyd-Warshall algorithm and introduction to dynamic programming paradigm. More examples of dynamic programming.

### **Modulo Representation of integers/polynomials:**

Chinese Remainder Theorem, Conversion between base-representation and modulo-representation. Extension to polynomials. Application: Interpolation problem.

### **Discrete Fourier Transform (DFT):**

In complex field, DFT in modulo ring. Fast Fourier Transform algorithm. Schonhage-Strassen Integer Multiplication algorithm.

## **UNIT - V:**

**Linear Programming:** Geometry of the feasibility region and Simplex algorithm

**NP-completeness:** Examples, proof of NP-hardness and NP-completeness.

Recent Trends in problem solving paradigms using recent searching and sorting techniques by applying recently proposed data structures

### **TEXT BOOKS:**

1. Introduction to Algorithms — Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, 4th Edition, MIT Press, 2022.
2. Algorithm Design — Jon Kleinberg and Éva Tardos, 1st Indian Reprint, Pearson, 2014.
3. The Algorithm Design Manual — Steven S. Skiena, 2nd Edition, Springer, 2008.

### **REFERENCE BOOKS:**

1. Cormen, Leiserson, Rivest, Stein, "Introduction to Algorithms".
2. Aho, Hopcroft, Ullman "The Design and Analysis of Computer Algorithms".
3. Kleinberg and Tardos."Algorithm Design".

### **ELECTRONIC RESOURCES:**

1. <https://www.geeksforgeeks.org/fundamentals-of-algorithms/>
2. [https://www.tutorialspoint.com/algorithm\\_design/index.htm](https://www.tutorialspoint.com/algorithm_design/index.htm)
3. <https://www.coursera.org/specializations/algorithms>
4. <https://www.edx.org/learn/algorithms>

### **MATERIALS ONLINE:**

1. Course template
2. Tutorial question bank
3. Tech talk and Concept Video topics
4. Open-ended experiments
5. Definitions and terminology
6. Assignments
7. Model question paper – I
8. Model question paper – II
9. Lecture notes
10. E-Learning Readiness Videos (ELRV)