AMITY UNIVERSITY
UTTAR PRADESH

Course Title: ADVANCED ALGORITHMS
Course Level: DOCTORAL
Course Type: Elective
Course Code: CSIT901 **Credit Units: 4**

L	T	P/S	SW/FW	TOTAL CREDIT UNITS
3	1	-	-	4

Course Objectives:
The objectives of the course are:

- The students are able to analyze the algorithms based on asymptotic runtime and space complexity.
- The students can distinguish between the various algorithm designing techniques like Greedy algorithms, Dynamic Programming, Divide and Conquer, Backtracking, etc.
- The students learn to differentiate between P, NP, NP-Hard, NP-Completeness.

Pre-requisites: (i) Computer Architecture (ii) Data Structures (iii) Basic Mathematics

Course Contents/Syllabus:

	Weightage (%)
Module I : Introduction to algorithms	25
Algorithms; Space and time complexity; Asymptotic notations; Recurrence relations (Substitution method; Iteration method; Recursion tree; Master Theorem). Sorting and Searching algorithms. *Data Structures-M*ore Advanced Solutions to Basic Data Structuring Problems: Fibonacci Heaps. Van Emde Boas Priority Queues. Dynamic Data Structures for Graph Connectivity/Reachability.	
Module III : Optimization Techniques	15
Dynamic Programming- Chain Matrix Multiplication; Longest Common Subsequence; Optimized Polygon triangulation problems. Greedy Algorithms – Activity Selection; Huffman Codes; Task Scheduling problem.	
Module III : Other algorithms	15

Maximum Flows-Augmenting Paths and Push-Relabel Methods. Minimum Cost Flows. Bipartite Matching. *Linear Programming*-Formulation of Problems as Linear Programs. Duality. Simplex, Interior Point, and Ellipsoid Algorithms. *External-Memory Algorithms*-Accounting for the Cost of Accessing Data from Slow Memory. Sorting. B-trees. Buffer Trees. Cache-oblivious Algorithms for Matrix Multiplication and Binary Search. *Computational Geometry*- Convex Hull. Line-segment Intersection. Sweep Lines. Voronoi Diagrams. Range Trees. Seidel's Low-dimensional LP Algorithm.	
Module V : Polynomial and FFT	15
Representing polynomials; Discrete Fourier Transforms; Fast Fourier Transforms.	
Module VI : String Matching	15
Naïve String Matching algorithm; Rabin Karp algorithm; Knuth Morris Pratt algorithm, Suffix Trees.	
Module VII: NP Completeness	15
Polynomial time verification; NP-Completeness and reducibility; NP-Complete problems. *Approximation Algorithms* One Way of Coping with NP-Hardness. Greedy Approximation Algorithms. Dynamic Programming and Weakly Polynomial-Time Algorithms. Linear Programming Relaxations. Randomized Rounding. Vertex Cover, Wiring, and TSP.	

Student Learning Outcomes:

After completion of the course, the student will be able:

- <u>Demonstrate</u> knowledge of how to measure the complexity of an algorithm, including best-case, worst-case, and average complexities as functions of the input size, as well as classification in terms of asymptotic complexity classes.
- <u>Recognize</u> different algorithmic design strategies which includes recursion, divide-and-conquer, the greedy method, dynamic programming, and backtracking and branch-and bound, etc.
- <u>Estimate</u> the Amortized runtime of the algorithms.
- <u>Relate</u> different real-world problems to computational problems and synthesize efficient algorithms for them.
- <u>Compare</u> different algorithm design strategies for any computational problem.
- <u>Identify</u> whether the algorithm belong to P, NP, NP-Complete or NP-Hard category.

Pedagogy for Course Delivery:

The subject will be taught with the help of

(i) Class room teaching in form of Lectures,

(ii) Tutorial sessions including Question – Answer sessions, Assignments and Group Discussions.

Assessment/ Examination Scheme:

Theory L/T (%)	Lab/Practical/Studio (%)	Total
100%	-	100%

Theory Assessment (L&T):

Continuous Assessment/Internal Assessment					End Term Examination
Components (Drop down)	Attendance	Class Test	Assignment	Case Study	
Weightage (%)	5%	10%	5%	10%	70%

Text & References:

- T .H . Cormen, C . E . Leiserson, R .L . Rivest "Introduction to Algorithms", PHI, 2nd Edition, 2004.
- A .V. Aho, J . E . Hopcroft, J . D . Ulman "The Design & Analysis of Computer Algorithms", Addison Wesley, Wesley, 1998.
- Ellis Horowitz, Sartaz Sahani and S. Rajasekaran "Fundamentals of Computer Algorithms", Galgotia Publication, 1999.
- D. E. Knuth, "The Art of Computer Programming", 2nd Ed., Addison Wesley, 1998.