CSE6072: Advanced Data Structures and Algorithms

Course: Program Elective Credits: 3 Hours: 40

Course Context and Overview (100 words):

Computer Programs constitute the basic building block in the gamut of Information Technology and it comprises of Data Structures and Algorithms. Data Structures enrich the representation of Information and Algorithms offer automatable logic to solve business or scientific or social problems. Designing efficient algorithms to problems is the essential skill needed by a computer professional to be competent. Efficient algorithms require very appropriate data-structures. Thus, there is a need to study a variety of data-structures and their usage in efficient algorithms. This course takes off from the background study of elementary Data Structures and Algorithms and introduces some advance Data Structures and Algorithms or their application in newer problems. The objective of this course is to strengthen the foundation and give opportunity to students to further sharpen their skills in Data Structures and Algorithms design.

Prerequisites Courses: Data Structures & Algorithms, Discrete Mathematics.

Course outcomes (COs):

On completion of this course, the students will have the ability to:
CO1 : Analyze the complexity of algorithms in terms of asymptotic notations
CO2 : Demonstrate familiarity with major data structures and algorithms
CO3 : Apply important algorithmic design paradigms and methods of analysis
CO4 : Formulate efficient algorithms to solve engineering problems
CO5 : Apply the data structures and algorithms to solve the real word problems

Course Topics:

Contents	Lecture Hours	
UNIT – 1 : Review of Basic Data Structure and Applications		10
1.1 Algorithm complexity and asymptotic notations	1	
1.2 AVL Tree, Red-Black Trees, 2-3 Tree, B-Tree, Skip List, Heaps: Binomial and Fibonacci.	8	

1.5 Data structures for disjoint sets: Union Find with applications	1	
Lab session	4	
UNIT-2: Data Structures and Algorithms for Hashing and Text Processing		9
2.1 Hashing: Fundamentals, Simple Uniform, Double Hashing, Universal & Perfect Hashing, Application.	3	
3 2.2 Text Processing: Pattern Matching – KMP algorithm, Boyer Moore algorithm	2	
2.3 Tries- Standard Tries, Compressed Tries, Suffix Tries.	3	
2.4 Implementation and Application of Text Processing Algorithms	1	
Lab session	4	
UNIT–3: Graph Algorithms, Implementation and their Applications		9
3.1 Review of basics Graph algorithm.	1	
3.2 Bidirectional-Dijkstra Algorithm, A* Search Algorithm, Parallel all-pairs shortest path algorithm, Johnson's Algorithm for sparse graph, Viterbi Algorithm.	4	
3.3 Maximum Flow: Flow Network, Ford-Fulkerson, Maximum Bipartite Matching, Push-relabel, Relabel-to-front.	4	
Lab session	4	
UNIT-4: Advancements in Data Structures and Algorithms		**12**
4.1 Sorting Networks: Comparison Networks, Zero-One Principle, Bitonic Sorting, Merging Network, Sorting Network Algorithm.	3	
4.2 String Matching: Naïve string-matching Algorithm, Rabin-Karp Algorithm, Knuth-Morris-Pratt Algorithm.	3	
4.3 Computational Geometry: Determining whether any pair of segment intersects, Finding the Convex Hull, Finding closest pair of points.	3	
4.4 Approximation Algorithms: Vertex-cover problem, TSP, Set-covering problem, subset-sum problem	3	
Lab Sessions	8	

Textbook references (IEEE format):
Text Book:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, *"Introduction to algorithms",* 3rd Edition, The MIT Press, 2009.

Reference books:

1. Goodrich, Michael T., and Roberto Tamassia. *"Algorithm design and applications",* Wiley Publishing, 2014.
2. Skiena, Steven S, *"The algorithm design manual*", 2nd Ed, Springer, 2012.
3. Robert Sedgewick and Kevin Wayen, "*Algorithms"*, 4th Edition, Addison-Wesley Professional, 2011.
4. Brass, Peter, "*Advanced data structures*", Cambridge University Press, 2008.
5. Mehta, Dinesh P., and Sartaj Sahni, *"Handbook of data structures and applications,* Chapman and Hall/CRC, 2004.
6. Motwani, Rajeev, and Prabhakar Raghavan "*Randomized algorithms*", Cambridge university press, 2000.
7. *"Additional Reading"*: Recent Research Papers.

Additional Resources (Video Lectures, Web resources etc.): NPTEL Video Lectures.

Evaluation:

Evaluation criteria will be shared by the concerned course instructor.

Prepared By: Sudheer K Sharma (contents are not modified --- but other points such as PE for UG (CSE & CCE) 4th Year 8th Semester and Evaluation components are suitably modified by Ravi Gorthi)
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List of Lab Experiments ADSA	
Lab-1	i. Implementation of AVL Tree Data structure ii. Implementation of Red-Black Tree Data structure
Lab-2	i. Implementation of 2-3 Tree Data structure ii. Implementation of B-Tree Data structure
Lab-3	i. Implementation of Simple Uniform & Double Hashing ii. Implementation of Universal & Perfect Hashing
Lab-4	i. Implementation of Tries Data structure ii. Implementation of KMP/ Boyer Moore Algorithm
Lab-5	i. Implementation of Parallel All Pair shortest path algorithm ii. Implementation of Johnson's/ Veterbi Algorithm
Lab-6	i. Implementation of Network flow with multiple source & sinks. ii. Implementation of Push-Relabel & Relabel-to-front Algorithm.
Lab-7	i. Implementation of Merging Network Algorithm. ii. Implementation of Sorting Network Algorithm.
Lab-8	i. Implementation of Rabin-Karp Algorithm ii. Implementation of Knuth-Morris-Pratt Algorithm.
Lab-9	**i.** Implementation of Algorithm for finding Convex Hull. **ii.** Implementation of Algorithm for finding closest pair of point in 2D/3D space.
Lab-10	Implementation/replication of recent Research paper on advanced Algorithms.