Course work for PhD students aspiring to work in "Algorithms and AI-ML"

Design and Analysis of Combinatorial Algorithms

A. **Description**
to be filled.

B. **Pre-requisites**
Basic programming skills.

C. **Outline of the syllabus**

1. Foundations: Introduction, Motivation,
2. Asymptotic complexity: informal concepts and formal notation, worst and average case analysis. Recurrence relations.
3. Sorting: bubble sort, insertion sort, selection sort, merge sort, quick sort, stability and other issues with sorting
4. Data Structures: Hash Tables, Binary Search Trees, Red-Black Trees, B-Trees, Fibonacci Heaps,
5. Elementary Graph Algorithms: BFS, DFS, Strongly connected components, topological sort,
6. Shortest paths: unweighted and weighted; Single source shortest paths: Dijkstra; Minimum cost spanning trees: Prim's algorithm, Kruskal's Algorithm; Union-Find data structure ;
7. Divide and conquer: counting inversions, nearest pair of points; Priority queues, heaps, Priority queues, heaps, Dijstra/Prims revisited using heaps
8. Search Trees: Introduction, Traversals, insertions, deletions; Balancing
9. Greedy Algorithms: Interval scheduling, Proof strategies, Huffman coding
10. Dynamic Programming: weighted interval scheduling
11. String Matching: The Rabin-Karp algorithm, The Knuth-Morris-Pratt algorithm
12. Intractability: NP-Completeness, reductions, examples
13. Approximation Algorithms: The vertex-cover problem, The traveling-salesman problem, The set-covering problem, Randomization and linear programming, The subset-sum problem

D. **Duration** 45 hours (15 weeks, 3 hours per week).

E. **Learning outcome and the objective of the course**
To be filled?

F. **Books and References**

(a) T. H. Cormen, C. E. Leiserson and R. L. Rivest: Introduction to Algorithms, PrenticeHall of India, New Delhi, 1998.

(b) A. Aho, J. Hopcroft and J. Ullman: The Design and Analysis of Computer Algorithms, A. W. L, International Student Edition, Singapore, 19983.

G. **Assessment methodology**
Written and Programming assignments, Examinations.

H. **Pedagogic methodology**
Lectures, presentations, and Programming sessions.

This course is proposed by Laltu Sardar and Ritankar Mondal