

DEPARTMENT OF CSE, NIT-ROURKELA
Autumn END-SEMESTER EXAMINATION 2019-2020

SUBJECT: **Data Structures & Algorithm Design**

CODE: **CS 6103**

FULL MARKS: 50

Duration of Examination: **3 Hours**

All Parts of a question should be answered at one place.

Answer any FIVE from the following including Question No. 1

- 1[a] Present the definition of an approximation ratio to measure the approximation quality of the greedy algorithm?
- 1[b] What two requirements should a problem satisfy in order to be suitable for solving it by a GA?
- 1[c] Choosing a random pivot point improves *quick sort* by removing the worst case due to bad data. What effect would happen to Insertion Sort if we chose a random element to insert rather than the next one in the input sequence?
- 1[d] What are PTAS and FPTAS? How the value of ϵ affects the running time in PTAS and FPTAS? Which one is better among PTAS and FPTAS? Why?
- 1[e] What is the lower bound of time complexity of any algorithm finding 5th largest key from n distinct keys stored in a linear array?

[2×5]

- 2[a] What are the different approaches to prove the correctness of an algorithm? Explain Loop Invariants associated with an algorithm? Use binary search algorithm to discuss the process of proving correctness?
- 2[b] Define convex hull in R^2 ? Show that solution space of finding a 2dimensional convex hull is exponential? Write Approximation algorithm for convex hulls for a set of n points with time complexity $O(n+k)$?

[5+5]

- 3[a] Show that “The number of a given schema in the next generation is a product of its fitness and its ability to survive crossover”? A search space consists of 10^6 points. Find the total number of schemata for binary and decimal coded genetic algorithm.
- 3[b] Define lower bound of a problem? What is the difference between worst case lower bound and average case lower bound? Find out the lower bound of heap sort algorithm.

[5+5]

- 4[a] Why should an approximation algorithm be polynomial? What are the main steps for designing an approximation algorithm? How does lower bound of a problem play role in deriving approximation ratio?
- 4[b] Discuss the concept of pattern matching algorithm? What is the advantage of Boyer-Moore method over Brute-Force method to match a pattern P in a given string T. Explain the concept of *looking-glass heuristic* and *character-jump heuristic* used in Boyer-Moore algorithm?

[5+5]

- 5[a] Given a set P of n points in 2D, a point $p \in P$ is said to be central if the x-coordinate of p has rank between $0.2n$ and $0.8n$ among the x-coordinates of P and the y-coordinate of p has rank between $0.2n$ and $0.8n$ among the y-coordinates of P. (Recall that the rank of an element z among a set refers to the number of elements smaller than z in the set. You may assume that coordinates are all distinct.). Design and analyze a **Las Vegas** linear-time algorithm for finding a central point in P.

DEPARTMENT OF CSE, NIT-ROURKELA
Autumn END-SEMESTER EXAMINATION 2019-2020

- 5[b] Define the traveling salesperson problem (TSP)? Suggest an approximation algorithm for Euclidean traveling salesperson problem? Compute an approximate solution for the TSP having the following distance matrix.

$$D = \begin{bmatrix} 0 & 3 & 5 & 9 \\ 3 & 0 & 6 & 7 \\ 5 & 6 & 0 & 9 \\ 9 & 7 & 9 & 0 \end{bmatrix}$$

[5+5]

- 6[a] Write a randomized algorithm (Quick select) to find the kth smallest element in an unsorted array? Prove that average case time complexity of Quick select is $O(n)$?
- 6[b] Consider a function maximization application of a GA. Suppose the 5 chromosomes at a given generation have fitness values listed below. Construct the “roulette wheel” for selection of parents for crossover.

$$f(x_1) = 55, f(x_2) = 24, f(x_3) = 8, f(x_4) = 19, f(x_5) = 42$$

[5+5]

- 7[a] Describe briefly the Travelling Salesman Problem? Illustrate your description by explicitly finding the shortest tour given the distances (or costs) between cities shown in the following Table.

Distances between cities.

To	A	B	C	D
From				
A	-	4	6	12
B	3	-	6	8
C	7	10	-	10
D	11	7	9	-

Describe briefly how a solution to the Travelling Salesman Problem might be obtained using a genetic algorithm, indicating how features of the problem map to the elements needed to use a genetic algorithm.

- 7[b] Explain how to implement first-fit and best-fit heuristic based approximation algorithm for bin packing algorithm in $O(n \log n)$ time.

[5+5]

- 8[a] Explain what are randomized algorithms? Why we need such algorithms? What is the complexity class **Randomized Polynomial time (RP)**?
- 8[b] Consider genetic algorithms using only selection and mutation operators (no crossover). Is this equivalent to another search algorithm? Justify your answer?
- 8[c] Compute a table representing the KMP failure function for the pattern “amalgamation”.
- 8[d] Find the defining length and order of the following schemata of the form ★1★1★0★, ★11★ ★ ★ ★, 111111★, ★★1★ ★ ★ 1.
- 8[e] Why approximation algorithms are used to solve NP-hard problem? What do you mean by polynomial-time approximation algorithm?

[2×5]

-----* Good luck *-----