DEPARTMENT OF CSE, NIT-ROURKELA
Mid Term Autumn Examination 2021

SUBJECT: **Data Structures & Algorithm Design** CODE**: CS 6103**

FULL MARKS: 20+10 Duration of Examination**: 2 Hours**

25th October 2021(Friday) 3-5PM

[Answer any five from the following]

All question should be answered by own hand writing and uploaded to MS team

[Start time 3.00PM, Finish time 4.30PM, Upload on or before 4.45PM]

[Quiz Start Time-4.50PM, Close Time 5.20PM]

1[a] 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[b] What is the complexity class Zero-error Probabilistic Polynomial time **(*ZPP*)?**

1[c] What is reducibility in the context of NP-completeness?

1[d] How does the Dynamic Programming paradigm differs from the Greedy paradigm?

[4]

2[a] Explain the steps to prove a problem to be NP-Complete?

2[b] Suggest a randomized algorithm to identifying the ***Repeated Element*** from an array of n elements. Prove the run time of your algorithm?

[4]

3[a] Give the algorithm of Binary search. Explain how it functions? Devise a ternary search algorithm that first tests the element at position n/3 for equality with some value x, and then checks the element at 2n/3 and either discovers x or reduces the set size to one-third the size of the original. Compare this with binary search?

3[b] What are the different sources of random number? Suggest an randomized algorithm to compute the value of π . What is the complexity of the algorithm?

[4]

4[a] How decision problems are related to P or NP classes? Explain the how the concept of reducibility is used to solve the decision problem A in polynomial time.

4[b] Write a randomized algorithm for 0-1 knapsack problem? Comment on class to which you algorithm belongs?

[4]

5[a] Define and differentiate between deterministic and Non-deterministic algorithm.

5[b] Write a non-deterministic algorithm to find the index of a maximum element in a list of *n* elements. Discuss its complexity class with reference to randomized algorithm?

[4]

6[a] What is the main difference between *Las Vegas* and *Monte Carlo* algorithms? What are the four complexity classes involving randomized algorithms? Explain with examples?

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Mid Term Autumn Examination 2021

6[b] The Majority-Element Problem**:** Given a sequence of *n* elements where each element is an integer in [1, *k*], Write a randomized algorithm to return the majority element (an element that appears more than *n*/2 times) or zero if no majority element is found.

[4]

7[a] How to prove a problem to be NP-hard ?

7[b] Write a randomized algorithm to find a minimum-spanning tree for undirected graph. What is the time complexity of these algorithms? Explain how representation of the graph affects complexity measure?

[4]

[8] A ship is to be loaded with containers, and every container is the same size, but may have a different weight from other containers. There are n containers and we write w_i for the weight of the *i*th container. The capacity, or maximum weight, that the ship can safely bear is *c*. Initially we wish to load the ship with the *maximum number of containers*.

(a) Formulate the problem as an optimization problem with a *constraint* and an *optimization function*.

(b) Formulate good greedy algorithm and non-deterministic algorithm to solve this problem.

[4]

9[a] Give a Sherwood-type sorting algorithm?

9[b] Write a non-deterministic algorithm to find the k^{th} smallest element in a list of n elements. The k^{th} smallest element is the one that would be in position *k* if the array were sorted?

[4]

[10] Suppose a student taking a test wants to maximize the test score. There are ***n*** questions, each question is worth the same number of points but Question ***i*** takes ***T[i]*** minutes to solve. The total test time is ***K*** minutes. No credit will be given for incomplete questions. Give an **O(*nlogn*)** time greedy strategy that maximizes the test score (i.e., maximizes the total number of completed test questions).

[4]

----------Submit your answer on or before 4.45PM----------

Instruction:

- The examination is hand written close book examination, followed by a Quiz test [MCQ].
- The examination will be in two part [20+10] marks], Assignments will be available with MS team (code **y1npi6v**)
- Write your Name and Roll number clearly in top of your answer sheet.
- You have to upload the scan copy of your hand written answer sheet (pdf format only) in MS team (appropriate assignment) on or before **4.45PM.**
- Rename your submission file as **Rollno_DSAD**; the student with roll no 117CS0246 has to rename the answer file for the Question as **117CS0246_DSAD**.
- Call me on 9937324437 or 9337938766 for any assistance during the examination. My E-mail id is bdsahu@nitrkl.ac.in, bibhudatta.sahoo@gmail.com.

----------✱ Good luck ✱----------