Jaypee Institute Of Information Technology T1

Test-1 Even Semester 2020-2021
B.Tech.
Course Title: Algorithms and Problem Solving
Course Code: 15B11CI411
Maximum Marks: 20
Maximum Time: 01 hr + (15 minutes for uploading)

Note:
1. This is a paper and pen examination. Answers have to be written on papers only in your own handwriting. No answer has to be given on Google Form.
2. Write on the first page, your name, enrollment number, Batch, Subject Name, Subject Code and Date of Exam and name , Enrollment number and page numbering on subsequent pages compulsorily.
3. Answers should be uploaded collectively in a single .pdf file at the end of examination.
4. Answers must be written in order of questions and no space should be left between answers of two subsequent questions.

* Required

1.   Name *

    _____

2.   Enrollment Number *

    _____

3.   Batch *

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4.   Q1 to Q5

Q1. **[CO1] [1 mark]** How many times L and k would be compared and how many times function F1() will be called in the following code?

```
for (int L=1; L<k; L=L*3)
    F1();
```

Q2. **[CO1] [1 mark]** Provide a recurrence relation for the execution time of the following function:

```
F2(K)
{        If(K>1)
                {
                 j= F2(K-1);
                 return j++;
                }
         else
                return 1;
}
```

Q3. **[CO1] [1 mark]** Prove that: $5n+3 = \omega(\log(n))$.

Q4. **[CO1] [1 mark]** Solve the given recurrence using Master Theorem.

$T(n) = 9T(n/3) + n^2, (T(1) = 1)$

Q5. **[CO3] [1 mark]** Amazon has decided to use counting sort algorithm to sort millions of products by their 15-digit serial numbers. Is it the right decision? Justify your answer.

5. Q6 to Q10

Q6. **[CO1] [1 mark]** Professor Sujata uses the following algorithm for merging k sorted lists, each having n/k elements. She takes the first list and merges it with the second list using a linear-time algorithm for merging two sorted lists, such as the merging algorithm used in merge sort. Then, she merges the resulting list of 2n/k elements with the third list, merges the list of 3n/k elements that results with the fourth list, and so forth, until she ends up with a single sorted list of all elements. The worst-case running time of the professor's algorithm in terms of n and k is?

Q7. **[CO2] [1 mark]** You are given a set of values as shown: A= [-1,16,3,9,8,6,7,4,19,25,18]

Suppose you constructed the segment tree for minimum in a range query in A. After constructing the required segment tree, how many numbers of comparisons will be required if you want to find what is the minimum in the range of [4,10].

Q8. **[CO2] [1 mark]** Suppose you created a segment tree for finding sum in a given range queries and inserted the following elements in it.

-1,16,3,9,8,6,7,4,19,25,18.

What will be the root value of the created segment tree?

Q9. **[CO2] [1 mark]** Parent and children of a node in the segment tree can be found at what index value if it is implemented using static array and how much size of memory would be allocated for such segment tree?

Q10. **[CO2] [1 mark]** What red-black tree property is violated in the tree below? Show the tree after you restore the red-black tree property in this case.
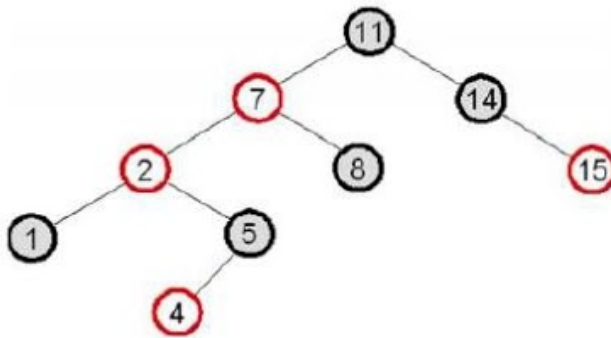
6. Q11&Q12

Q11. **[CO3] [2 marks]** You are given two databases, where each database contains n numerical values. Further assume that the values are distinct and sorted. We are also given a function f() to access the numerical values from any one of the two databases. For the given database and value k, Function f() outputs the kth smallest value that the given database contains. The function f() takes O(1). We would like to determine the nth smallest value, or in other words median, out of these 2n values. Give an algorithm which finds the median value using O(logn) queries only.

Q12. **[CO1] [2 marks]** Write the recurrence relation and analyse the time complexity (in terms of Big O) of recursive algorithm **do_something()** given below.

void do_something (A[1..n])
{
   If (n>1)
      do_something (A[1...n/2]);
      do_something (A[n/2+1...n]);
      do_something_else(A[1..n]);
}
	void do_something_else(A[1..n])
	{
	   If(n==2)
	    If(A[1]>A[2])
	      swap A[1] and A[2];
	   else
	   { for i= 1 to n/4
	         swap A[i + n/4] and A[i + n/2]
	      // end of for loop
	
	      do_something_else (A [1.. n/2]);
	      do_something_else (A [n/2 +1 ... n]);
	      do_something_else (A [n/4 +1 ...3n/4]);
	   }
	}

7. Q13

Q13. **[CO4] [3 marks]** JIIT wants to prepare an interesting application for JIIT Alumni. Its functionality is explained as follows: The application requires to store a data set "D" of all JIIT faculty till date (from the beginning) with following fields: Faculty_ID, Faculty_name, JIIT joining year and JIIT leaving year (this field is equal to current year if faculty is still working with JIIT). This data set D needs to be stored in such a data structure such that thousands of Alumni students can perform following types of queries/searches on this data set in an efficient manner.

Query 1: An alumni wants to know who all faculty were there in JIIT during his stay at JIIT. So, he enters his batch like 2013-2017 batch and application returns all JIIT faculty details who worked with JIIT in that duration.

Query 2: An alumni wants to know that during his particular year (second year or third year etc) at JIIT, who all faculty were there in JIIT. So, he enters a year like 2015 and application returns all JIIT faculty details who worked with JIIT in 2015.

a) Propose an appropriate Data structure to store faculty dataset D so that above queries are efficiently processed. Write the Node structure of your proposed Data structure.
b) Propose an efficient algorithm for Query 2.
c) Show the complexity analysis of your proposed algorithm.

8. Q14

Q14. **[CO2] [3 marks]** You have been given a scenario below. Read the scenario carefully and apply the mentioned operations.

Scenario: Airport authority of India wants to store the details of flights (like flight number, source, destination etc) in a non-linear data structure and after that perform some queries like searching a flight, inserting a new flight, deleting/cancelling a flight. In the pandemic times, few people search for the flights (hence 'search a flight' query is less frequent). Whereas, a large number of flights get cancelled (deleted) and added (inserted) daily in the chosen data structure.

Which data structure would you suggest to store the flight details? For flight numbers given below, perform the following operations on chosen data structure in the given order (show all the steps).

Insert: 1, 3, 5, 7, 9, 2, 6, 8, 4

Delete: 5, 1, 9

9. Upload handwritten answer sheet (scanned single pdf file only) Nomenclature: batch_enrollmentnumber_name_APS_T1.pdf *

Files submitted:

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