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3 (Sem-4/CBCS) CSC HC 1

2022

**COMPUTER SCIENCE**

(Honours)

Paper : CSC-HC-4016

**(Design and Analysis of Algorithms)**

Full Marks : 60

Time : Three hours

**The figures in the margin indicate  
full marks for the questions.**

1. Answer the following questions as directed :  
(any seven) 1×7=7
  - (a) The non-ambiguity requirement for each step of an algorithm can be compromised. (State True or False)
  - (b) An algorithm is said to be correct if, for every input instance, it halts with the correct output.  
(State True or False)

Contd.

(c) When we have only an *asymptotic upper bound*, we use

- (i) O-notation (big O)
- (ii)  $\Theta$ -notation (big Theta)
- (iii)  $\Omega$ -notation (big Omega)
- (iv)  $\omega$ -notation (little omega)

(Choose the correct option)

(d) Which of the following sorting algorithms use divide-and-conquer technique?

- (i) Quick sort
- (ii) Radix sort
- (iii) Merge sort
- (iv) Both (i) and (ii)

(Choose the correct option)

(e) Which of the following uses the largest amount of auxiliary space for sorting?

- (i) Bubble sort
- (ii) Counting sort
- (iii) Quick sort
- (iv) Heap sort

(Choose the correct option)

(f) In a red-black tree, if a node is red, then both its children are black.

(State True or False)

(g) A red-black tree with  $n$  internal nodes has height at most  $2 \log(n + 1)$ .

(State True or False)

(h) Which of the following is not the algorithm to find the minimum spanning tree of the given graph?

- (i) Prim's algorithm
- (ii) Kruskal's algorithm
- (iii) All of the above
- (iv) None of the above

(Choose the correct option)

(i) \_\_\_\_\_ data structure is used in depth-first search algorithm.

(Fill in the blank)

(j) KMP is a linear-time string-matching algorithm.

(State True or False)

2. Answer the following questions : **(any four)**

2×4=8

- (a) What is greedy algorithm?
- (b) What is dynamic programming?
- (c) What is worst case and average case running time for bucket sort algorithm?
- (d) When does insertion sort take maximum time and minimum time?
- (e) When is a sorting algorithm said to be stable?
- (f) Why is counting sort algorithm not a comparison-based algorithm?
- (g) Why is red-black tree said to be a self-balancing tree?
- (h) State *any two* differences between DFS and BFS.

3. Answer **any three** of the following questions :

5×3=15

- (a) What is meant by efficiency of an algorithm? How is efficiency measured?
- (b) How to prove that an algorithm is correct?
- (c) What does dynamic programming have in common with divide-and-conquer? What is a principal difference between them?
- (d) How does divide-and-conquer algorithm work?
- (e) Write down the steps of bubble sort algorithm.
- (f) Does Prim's algorithm always work correctly on graphs with negative edge weights?
- (g) State the properties of a red-black tree.
- (h) Explain the working of Kruskal's algorithm using an example.

4. Answer **any three** of the following questions :  $10 \times 3 = 30$

(a) Use the bubble sort to put the numbers 3, 2, 4, 1, 9, 5 into ascending order. Illustrate the output of each pass clearly.

(b) Write the quick sort algorithm.

(c) Consider the following values stored in an array. Sort it in ascending order using heap sort technique showing all the iterations.

1, 9, 2, 8, 6, 5, 3, 4

(d) Show the red-black trees that result after successively inserting the keys 41, 38, 31, 12, 19, 8 into an initially empty red-black tree.

(e) Write the pseudocode for deleting a node from a red-black tree.

(f) Write down the steps of binary search algorithm.

(g) Write down the steps of DFS and BFS algorithms.

(h) Write pseudocode for Knuth-Morris-Pratt matching algorithm.