Dhirubhai Ambani Institute of Information and Communication Technology

Algorithms and Data Structure (IT623)

Timing: 1 hour 30 mins | Max mark: 25

Section A (Objective Questions) **Max mark: 10**

Each question carry 1 marks. Only one choice is correct for each question.

1. How many distinct binary search trees can be created out of 4 distinct keys?
   (a) 4
   (b) 14
   (c) 24
   (d) 42

2. What is the value of the postfix expression 6 3 2 4 + – *?
   (a) 1
   (b) 40
   (c) 74
   (d) -18

3. Which of the following Binary Min Heap operation has the highest time complexity?
   (a) Inserting an item under the assumption that the heap has capacity to accommodate one more item
   (b) Merging with another heap under the assumption that the heap has capacity to accommodate items of other heap
   (c) Deleting an item from heap
   (d) Decreasing value of a key

4. Traversal of a graph is somewhat different from the tree because

(a) There can be a loop in a graph, so we must maintain a visited flag for every vertex

(b) DFS of a graph uses the stack, but the inorder traversal of a tree is recursive

(c) BFS of a graph uses a queue, but a time-efficient BFS of a tree is recursive.

(d) All of the above

5. What are the suitable data structures for the following algorithms?

1) Breadth-First Search
2) Depth First Search
3) Prim's Minimum Spanning Tree
4) Kruskal's Minimum Spanning Tree

(a) 1) Stack
2) Queue
3) Priority Queue
4) Union/Component Find

(b) 1) Queue
2) Stack
3) Priority Queue
4) Union/Component Find

(c) 1) Stack
2) Queue
3) Union/Component Find
4) Priority Queue

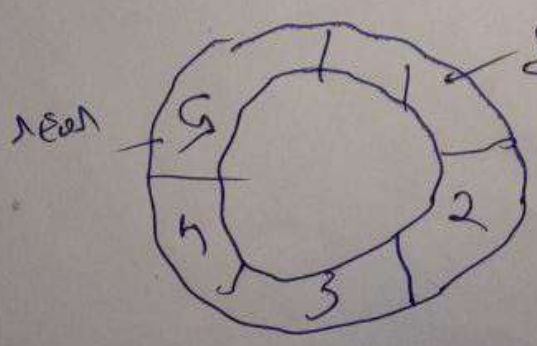
(d) 1) Priority Queue
2) Queue
3) Stack
4) Union/Component Find

6. Suppose a circular queue of capacity (n – 1) elements is implemented with an array of n elements. Assume that the insertion and deletion operation are carried out using REAR and FRONT as array index variables, respectively. Initially, REAR = FRONT = 0. The conditions to detect queue full and queue empty are

(a) Full: (REAR+1) mod n == FRONT, empty: REAR == FRONT

(b) Full: (REAR+1) mod n == FRONT, empty: (FRONT+1) mod n == REAR

(c) Full: REAR == FRONT, empty: (REAR+1) mod n == FRONT



0 1 2 3

3

3 mod 3 = ?

(d) Full: (FRONT+1) mod n == REAR, empty: REAR == FRONT

7. In the worst case, the number of comparisons needed to search a singly linked list of length n for a given element is

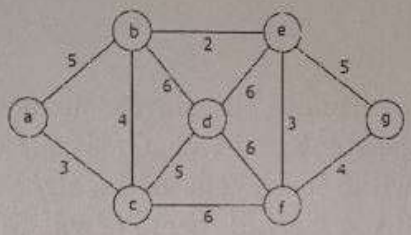
   (a) $\log_2$ n

   (b) $n/2$

   (c) $\log_2$ n-1

   (d) n

8. Consider the following graph: Which one of the following is NOT the sequence of



   edges added to the minimum spanning tree using Kruskal's algorithm?

   (a) (b,e)(e,f)(a,c)(b,c)(f,g)(c,d)

   (b) (b,e)(e,f)(a,c)(f,g)(b,c)(c,d)

   (c) (b,e)(a,c)(e,f)(b,c)(f,g)(c,d)

   (d) (b,e)(e,f)(b,c)(a,c)(f,g)(c,d)

9. A priority queue can efficiently implemented using which of the following data structures? Assume that the number of insert and peek (operation to see the current highest priority item) and extraction (remove the highest priority item) operations are almost same.

   (a) Array

   (b) Linked List

   (c) Heap Data Structures like Binary Heap, Fibonacci Heap

   (d) None of the above

10. The preorder traversal of a binary search tree is 15, 10, 12, 11, 20, 18, 16, 19. Which one of the following is the postorder traversal of the tree?

    (a) 20, 19, 18, 16, 15, 12, 11, 10

(b) 10, 11, 12, 15, 16, 18, 19, 20

(c) 11, 12, 10, 16, 19, 18, 20, 15

(d) 19, 16, 18, 20, 11, 12, 10, 15

Section B (Subjective Questions) **Max mark: 15**

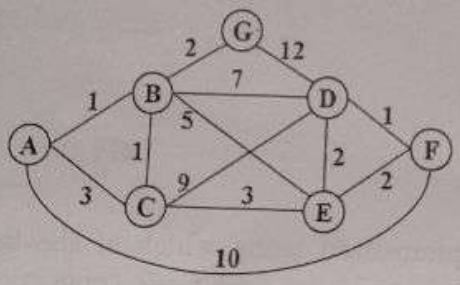
Each question carry 5 marks.

1. From the sequence:
   13, 3, 4, 12, 14, 10, 5, 1, 8, 2, 7, 9, 11, 6, 18

   (a) Create BST using the sequence as input

   (b) Delete 4, 10, 2, 7 and 13

2. Step through Dijkstra's algorithm to calculate the single-source shortest paths from A to every other vertex. Show the steps in detail. Cross out old values and write in new ones, from left to right within each cell, as the algorithm proceeds. Also list the vertices in the order which you marked them known. Finally, indicate the lowest-cast path from node A to node F.



3. Given the array of elements 8, 4, 7, 1, 3, 5 sort the elements using heap sort. *Use* max heap data structure to perform the sorting. Show each operation *clearly.*

Best wishes

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Section A (Objective Questions) **Max mark: 10**

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1. What is the average case time complexity for finding the height of the binary tree?
   (a) h = O(loglogn)
   (b) h = O(nlogn)
   (c) h = O(n)
   (d) h = O(log n)
2. Consider the following heap after buildheap phase. What will be its corresponding array?
   (a) 26, 53, 41, 97, 58, 59, 31
   (b) 26, 31, 41, 53, 58, 59, 97
   (c) 26, 41, 53, 97, 31, 58, 59
   (d) 97, 53, 59, 26, 41, 58, 31
3. In heap sort, after deleting the last minimum element, the array will contain elements in?
   (a) increasing sorting order
   (b) decreasing sorting order
   (c) tree inorder
   (d) tree preorder
4. What is the typical running time of a heap sort algorithm?

(a) O(N)

(b) O(N log N)

(c) O(log N)

(d) $O(N^2)$

5. Suppose the numbers 7 , 5 , 1 , 8 , 3 , 6 , 0 , 9 , 4 , 2 are inserted in that order into an initially empty binary search tree. The binary search tree uses the usual ordering on natural numbers.

   What is the inorder traversal sequence of the resultant tree?

   (a) 7 , 5 , 1 , 0 , 3 , 2 , 4 , 6 , 8 , 9

   (b) 0 , 2 , 4 , 3 , 1 , 6 , 5 , 9 , 8 , 7

   (c) 0 , 1 , 2 , 3 , 4 , 5 , 6 , 7 , 8 , 9

   (d) 9 , 8 , 6 , 4 , 2 , 3 , 0 , 1 , 5 , 7

6. The preorder traversal sequence of a binary search tree is-
   30 , 20 , 10 , 15 , 25 , 23 , 39 , 35 , 42
   What one of the following is the postorder traversal sequence of the same tree?

   (a) 10 , 20 , 15 , 23 , 25 , 35 , 42 , 39 , 30

   (b) 15 , 10 , 25 , 23 , 20 , 42 , 35 , 39 , 30

   (c) 15 , 20 , 10 , 23 , 25 , 42 , 35 , 39 , 30

   (d) 15 , 10 , 23 , 25 , 20 , 35 , 42 , 39 , 30

7. Consider a hash table of size seven, with starting index zero, and a hash function (7x+3) mod 4. Assuming that the hash table is initially empty, which of the following is the contents of the table when the sequence 1, 3, 8, 10 is inserted into the table using closed hashing? Here "_" denotes an empty location in the table.

   (a) 3, 10, 1, 8, _ , _ , _

   (b) 1, 3, 8, 10, _, _, _

   (c) 1, _, 3, _, 8, _, 10

   (d) 3, 10, _, _, 8, _, _

8. A binary search tree is generated by inserting in order of the following integers-
   50, 15, 62, 5, 20, 58, 91, 3, 8, 37, 60, 24
   The number of nodes in the left subtree and right subtree of the root respectively is.

(a) (4, 7)

(b) (7, 4)

(c) (8, 3)

(d) (3, 8)

9. Given the following input (4322, 1334, 1471, 9679, 1989, 6171, 6173, 4199) and the hash function x mod 10, which of the following statements are true?

   (a) 9679, 1989, 4199 hash to the same value

   (b) 1471, 6171 hash to the same value

   (c) All elements hash to the same value

   (d) Each element hashes to a different value

      i. a only

      ii. b only

      iii. a and b only

      iv. c or d

10. A Hash Function f is defined as f(key) = key mod 7. With linear probing while inserting the keys 37, 38, 72, 48, 98, 11, 56 into a table indexed from 0, in which location key 11 will be stored (Count table index as location)?

    (a) 3

    (b) 4

    (c) 5

    (d) 6

Section B (Subjective Questions) **Max mark: 15**

Each question carry 5 marks.

1. Create Binary Search Tree from the sequence:
   15, 10, 20, 8, 12, 16, 25

   (a) Write algorithm and pseudocode for inserting a new element in the BST.

   (b) Insert 18 and draw the BST.

   (c) Write algorithm and pseudocode for deleting an element from BST.

   (d) Delete 20 and draw the BST.

(b) 10, 11, 12, 15, 16, 18, 19, 20
(c) 11, 12, 10, 16, 19, 18, 20, 15
(d) 19, 16, 18, 20, 11, ...

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2. Given the sequence 4, 3, 7, 1, 8, 5 perform sorting using heap sort and sort the sequence. Show each and every of the tree operations in heap sort.

3. The keys 12, 18, 13, 2, 3, 23, 5 and 15 are inserted into an initially empty hash table of length 10 using open addressing with hash function $h(k) = k \bmod 10$ and linear probing. What is the resultant hash table?

Best wishes

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Section A (Objective Questions)

Max mark: 10

1. Which of the following option is true while implementation of Queue is using the linked list?

   - ◯ In enqueue operation, new nodes are inserted from the beginning and in dequeue operation, nodes are removed from the end.
   - ◯ In enqueue operation, new nodes are inserted from the end and in dequeue operation, nodes are deleted from the end.
   - ◯ None of above
   - ◯ All of the above

2. Which one of the following is not the type of the Queue?

   - ◯ Linear Queue
   - ◯ Circular Queue
   - ◯ Double ended Queue
   - ◯ Single ended Queue

3. Consider an implementation of unsorted singly linked list. Suppose it has its representation with a head pointer only. Given the representation, which of the following operation can be implemented in O(1) time?

   1. Insertion at the front of the linked list
   2. Insertion at the end of the linked list
   3. Deletion of the front node of the linked list
   4. Deletion of the end node of the linked list

   - ◯ 1 and 2

- ◯ 1 and 3
- ◯ 1, 2 and 3
- ◯ 1, 2 and 4

4. In linked list implementation of queue, if the only front pointer is maintained, which of the following operation take worst-case time?
   - ◯ Insertion
   - ◯ Deletion
   - ◯ To empty a queue
   - ◯ Both Insertion and Deletion

5. Which of the following is the disadvantage of the array?
   - ◯ Stack and Queue data structures can be implemented through an array.
   - ◯ Index of the first element in an array can be negative
   - ◯ Wastage of memory if the elements inserted in an array are lesser than the allocated size
   - ◯ Elements can be accessed sequentially.

6. Which of the following is the prefix form of A+B*C?
   - ◯ A+(BC*)
   - ◯ +AB*C
   - ◯ ABC+*
   - ◯ +A*BC

7. Which one of the following is the overflow condition if linear queue is implemented using an array with a size MAX_SIZE?
   - ◯ rear = front
   - ◯ rear = front+1
   - ◯ rear= MAX_SIZE -1
   - ◯ rear = MAX_SIZE

8. In the linked list implementation of queue, where will the new element be inserted?
   - ◯ At the middle position of the linked list
   - ◯ At the head position of the linked list

- ○ At the tail position of the linked list
- ○ None of the above

9. Which of the following statement is not true about the doubly linked list?
   - ○ We can traverse in both the directions.
   - ○ It requires extra space
   - ○ Implementation of doubly linked list is easier than the singly linked list
   - ○ It stores the addresses of the next and the previous node
10. Which of the following is not the correct statement for a stack data structure?
   - ○ Arrays can be used to implement the stack
   - ○ Stack follows FIFO
   - ○ Elements are stored in a sequential manner
   - ○ Top of the stack contains the last inserted element

Section B **Max mark: 15**

- Convert the following infix expression to it's equivalent prefix expression:
  $K + L - M * N + (O + P) * W/U/V * T + Q$
- Write an algorithm and supporting pseudocode for finding the Nth node from the end of a linked List.
- Create a data structure twoStacks that represents two stacks. Implementation of twoStacks should use only one array, i.e., both stacks should use the same array for storing elements.

  Following functions must be supported by twoStacks.

  push1(int x) → pushes x to first stack
  push2(int x) → pushes x to second stack
  pop1() → pops an element from first stack and return the popped element
  pop2() → pops an element from second stack and return the popped element

Best wishes