University of Sargodha

BS 3rd Term Examination 2022

Subject: I.T **Paper: Data Structures & Algorithm (CMPC-203)**

Time Allowed: 02:30 Hours **Maximum Marks: 60**

Note: Objective part is compulsory. Attempt any three questions from subjective part.

Objective Part (Compulsory)

Q.1. Write short answers of the following in 2-3 lines each on your answer sheet. (2*12)

i. Declare the structure of a node using JAVA of a singly linked list.
ii. Why we use queues as data structure?
iii. What is meant by greedy algorithms?
iv. What is meant by asymptotic notations?
v. What is meant by time complexity of an algorithm?
vi. State the difference between primitive and non-primitive data types.
vii. Give an example of reference in JAVA.
viii. How many pointers are used while using stack as data structure and why?
ix. What is minimum spanning tree?
x. Write prefix equivalent of A + B * C.
xi. Define Hashing.
xii. What is ultimate benefit of sorting in data structures?

Subjective Part (3*12)

Q.2. Convert the following infix expression into postfix using stack. (^ indicates exponentiation)
A – B / (C * D ^ E)

Q.3. Write a function in JAVA that accepts reference of starting node of singly linked list and adds as the first node in the list.

Q.4. Write a function in JAVA to implement the INSERTION SORT.

Q.5. Make a BST for the following sequence of numbers and traverse it by using all types of traversal.
1, 2, 3, 4, 5, 6, 7, 13, 14, 15, 20, 25

Q.6. Write a function in java to implement binary search recursively.

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Data Structures & Algorithm (CMPC-203)

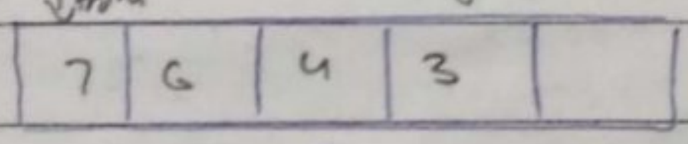
SHORT QUESTIONS

ii- Why we use queues as datastr?

Queue is a FIFO (First-In, First-Out) list, a list-like structure that provides restricted access to its elements: elements may only be inserted at the back & removed from front, queues are less flexible than lists

Enqueue: insert elements into queue at the back.

Dequeue: remove elements from the front.



QUEUE

Implementation = Arrays linked lists, pointers & structures

iii - what is meant by greedy algorithms?

An algorithm that always takes the best immediate, or local, solution while finding an answer.

They find the overall, or globally, optimal solution for some optimization problems, but may find less-than-optimal solutions for some instances of other problems.

Examples: Dijkstra's Shortest Path Algorithm
Problem Solving for Minimum Spanning Trees

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It is used to describe the running time of an algo. & how much time an algo takes with a given input.

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iv- What is meant by asymptotic notations?

They are languages that allow us to analyze an algorithm's running time by identifying its behaviour as the input size for the algorithm increases. This is also known as an Algorithm's growth rate. Big-Oh(O), Omega(π), & theta(θ) notations are asymptotic

v- What is meant by time complexity of an algorithm?

Time complexity is a concept in computer science that deals with the quantification of the amount of time taken by a set of code or algorithm to process or run as a function of the amount of input.

It is essentially efficiency, or how long a program fuction takes to process a given input.

vi- State the diff. btw primitive & non-primitive data types.

PRIMITIVE DATA STR	NON-PRIMITIVE DATA STR.
• They are basic data str. that directly operate upon the machine instructions. They have diff. representations on diff. computers.	• They are more complicated data str. They emphsize on grouping same or diff. data items with relationship b/w each data item.

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• It starts with a lowercase letter • Its size depends on the data type	• It starts with an uppercase. • They all have same size.
• Floating point nos, character constants, string constants & pointers came under this category • It will always have a value	• Arrays, Lists [linear Lists (stack & queue), Non-Linear Lists (Graphs & trees)] & Files come under this category. • It can be null

vii - Give an example of reference in JAVA.

A variable whose type is a class contains a reference to an object of the class (the address of the memory location where the obj is allocated).

EXAMPLE:

```
String s;
s = "xxx";
```

~~The variable gets the value of the reference~~

The 1st statement declares a variable s of type String.

viii - How many pointers are used while using stack as data str. & why?

A stack is a linear data str. that follows the LIFO (Last-In-First-Out) principle. Stack has one end, whereas the Queue has two ends (front & rear). It contains only one pointer. top pointer pointing to the topmost element of the stack. whenever an element is added in the stack, it is added on the top of the stack. & the element can be deleted only from the stack.

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(x-) reverse = C*B+A

Symb	Prefix exp	op stack
C	C	*
*	C	*
B	CB	+
+	CB*	
A	CB*A	
	*+ABC	

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ix- What is minimum spanning tree? MST

A minimum spanning tree or minimum weight spanning tree is a subset of the edges of a connected, edge-weighted undirected graph that connects all the vertices together, without any cycles & with the minimum possible total edge weight.

That is, it is a spanning tree whose sum of edge weights is as small as possible.

$G = V, E$

x- Write prefix equivalent of A+B*C

+A*BC

The multiplication operator comes immediately before the operands B & C, denoting that * has precendence over +. The addition operator than appears before the A & the result of the multiplication

xi- DEFINE HASHING?

In computing, a hash table (hash map) is a data str which implements an associative array abstract data type, a structure that can map keys to values. A hash table uses a hash function to compute an index into an array of buckets or slots, from which the ~~desired~~ desired value can be found.

A technique used to uniquely identify a specific

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object from a group of similar objects. To convert a range of key values into a range of indexes of an array by using a hash function.

It is the process of transforming any given key or string of characters into another value. This is usually represented by a shorter, fixed-length value or key that represents & make it easier to find or employ the original string

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xii- What is ultimate benefit of sorting in data str?

It help you to make decisions on how data should be sorted in order toget the best performance possible.

Comparision Based algorithms use comparisons b/w elements in order to determine their position in the list;

INSERTION SORT & SELECTION SORT are examples of comparison based algorithms.

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i- Declare the str. of a node using JAVA of a singly linked list.

```
public class Node{
  public int data;          // Data stored in the node
  pubic Node next;          // Reference to the next node
```


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```
// Constructor
public Node(int data) {
  this.data = data;
  this.next = null;
}
}
```

LONG QUESTIONS

Q NO: 2 INFIX → POSTFIX

A - B / (C * D ^ E)

SYMBOL	POSTFIX STRING	OPSTACK
A	A	
-	A	
B	AB	-
/	AB	-/
(	AB	-/(
C	ABC	-/(
*	ABC	-/(*
D	ABCD	-/(*
^	ABCD	-/(*^
E	ABCDE	-/(*^
)	ABCDE ^ * / -	

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Q NO: 3 Write a function in JAVA that accepts reference of starting node of singly linked list & adds as the first node in the list.

```
public static void main
class chain {
class Node {
    int data;
   Node next;
  public Node(int data){
      this.data = data;
      this.next= null;
    }
}

    public Node head = null;
    public void add first(int data) {
     Node newNode =newNode(data);
          if(head==null){
            head= new Node;
        return;
    }
      Node temp =head;
       head = newNode;
       head.next= temp;
    }.
```


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Qno:4 Write a function in JAVA to implement the INSERTION SORT.

MA'AM:

```
public static void main (String [] args) {
    {
int arr[ ] = { 7, 8, 3, 2, 1 };
for(int i = 1; i< arr.length; i++)
{
    current =arr[i];
        j = i-1;
while ( j>=0 && curren < arr[j] )
    {
        arr [j+1] =arr[j];
            j--;
    }
        arr [j+1 ]= current;
}
}
```

YT:

```
For j = 2 to A length
key = A[j]
// insert A[j] into the sorted sequence A[1... j-1]
i = j -1
while i>0 & A[i]>key {
  A[i+1] = A[i]
  i = i-1 }
A [i+1 ] = key
```


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Qno:6 Write a function in java to implement binary search recursively

```
Public class BinarySearchRecursive {

public static int binarySearchRecursive (int[] arr, int target,
                                         int low, int high) {
    if (low>high) {
    return -1;                    // target element not found
    }
int mid= (low+high) /2;

if (arr[mid] == target) {
    return mid;                   // target element found at index
}                                                          mid
}

if (arr[mid] >target) {
return binarySearchRecursive(arr, target, low, mid-1);
    // search in the left half ↑
}

returnbinarySearchRecursive(arr, target, mid+1, high);
    // search in the right half
}

public static void main(String[] args) {
    int[] array = {2,4,7,10,15,19,22,25,28,31};
    int targetElement = 15;
```


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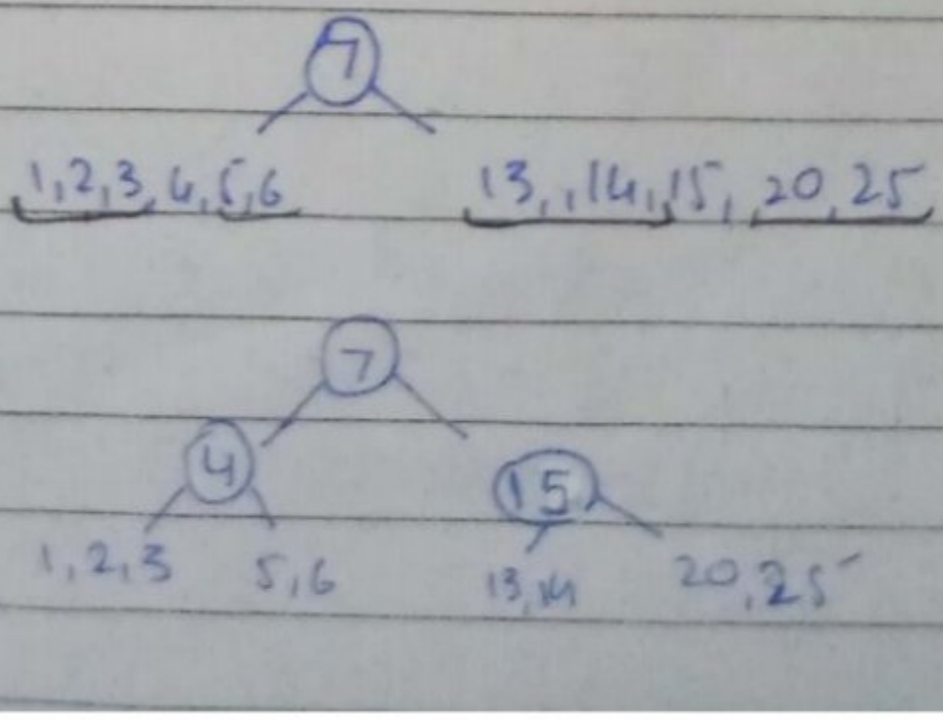
```
// perform binarysearch recursively
int result = binarySearchRecursive(array, target Element,
                0, array.length-1);

if (result != -1){
S.o.P("Element" + target Element + " found at index"
                        + result);
}
else{
S.o.P("Element" + targetElement + "not found in the
                                array.");
    }
  }
}
```

Qno:5 Make a BST for the following sequence of no:s & traverse it by using all types of traversal.

1, 2, 3, 4, 5, 6, 7, 13, 14, 15, 20, 25

1, 2, 3, 4, 5, 6, 7, 13, 14, 15, 20, 25



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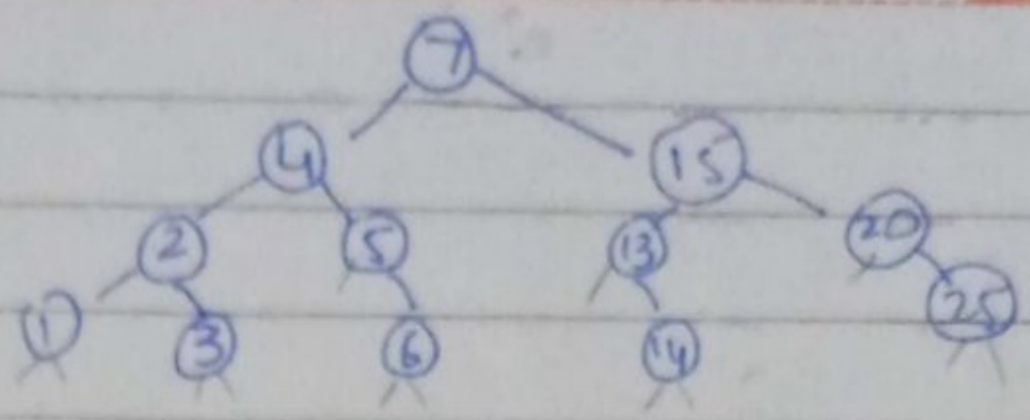

Pre-order: 7, 4, 2, 1, 3, 15, 13, 14, 20, 25

In-order: 1, 2, 3, 4, 5, 6, 7, 13, 14, 15, 20, 25

Post-order: 1, 3, 2, 4, 13, 14, 25, 20, 15, 7