School of Computing

Third CIA Exam – June 2022

Course Code: CSE209 Course Name: Data Structures & Algorithms

Duration: 90 minutes Max Marks: 50

PART - A

Answer all the questions **(10 x 2 = 20)**

1. Write the recursive algorithm to find the sum of elements in an array.

```
$Algorithm\ RSUM(A, n)$
$if\ n = 0$
    $return\ 0$
$else$
    $return\ A[n] + RSUM(A, n - 1)$
```

2. Find the complexity for the following algorithm:

```
$Algorithm\ \ MAXIMUM(A, n)$
// To find the maximum element in the array A of n elements
$max = A[1]$                    $1$
$for\ i = 1\ to\ n$             $n + 1$
    $if$ max $< A[i]$           $n$
        $max = A[i]$            $0\ to\ n$
$return\ max$                   $1$
```

$$T(n) = 1 + n - 1 + n + n + 1 = 3n + 1 \in \Theta(n)$$

3. Write the ADT for Stack.

Stack ADT

$S[1..MAXSIZE]$

TOP

Methods

$CreateStack(S) - Allocates\ contiguous\ memory\ of\ MAXSIZE\ for\ S\ and\ initializes\ TOP$

$ISEMPTY(S) - Returns\ TRUE\ if\ stack\ is\ empty\ otherwise\ FALSE$

$ISFULL(S) - Returns\ TRUE\ is\ stack\ is\ full\ otherwise\ FALSE$

$PUSH(S, x) - Inserts\ an\ element\ x\ into\ top\ of\ stack$

$POP(S) - Deletes\ \&\ returns\ the\ topmost\ element\ from\ stack$

$PEEK(S) - Retrieves\ \&\ returns\ the\ topmost\ element\ from\ stack$

4. Convert the following infix expression into equivalent postfix expression:
$a/b + (c + d) * (e - f) - g/h$
$(((a/b) + ((c + d) * (e - f))) - (g/f))$
$Postfix\ Expression: ab/cd + ef -* +gf/-$

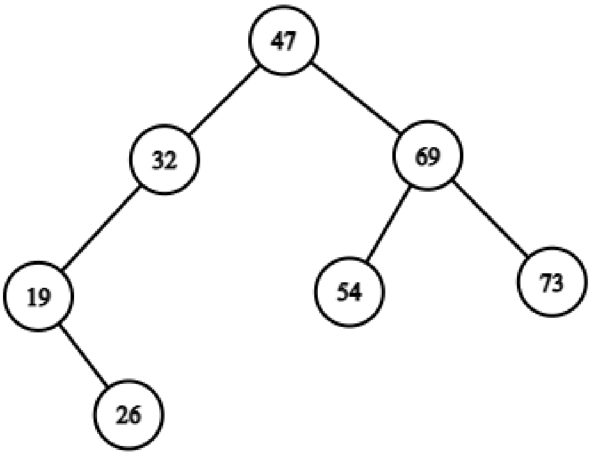
5. Draw the array representation for the following polynomial:
$P = 3x^9 - 7x^5 + 11x^2 - 20$

	1	2	3	4	5	6	7	8	9
P	4	9	3	5	7	2	11	0	-20

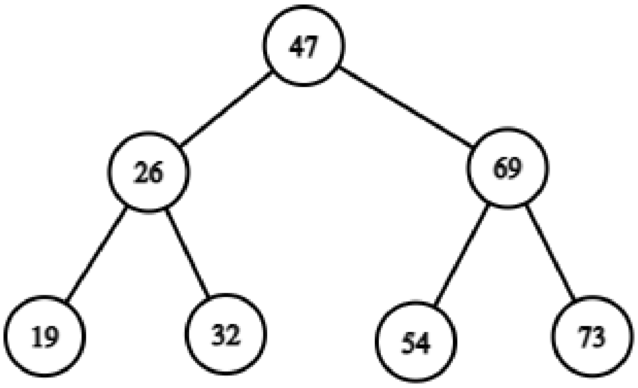
6. Write an algorithm to search for the position of a given element x in a singly linked list.

```
$\boldsymbol{Algorithm\ SEARCH\_SLL(FIRST, x)}$
$//\boldsymbol{Searching\ for\ an\ element\ x\ in\ a\ singly\ linked\ list}$
    $cur = FIRST$
    $count = 1$
    $while\ cur \neq NULL\ and\ cur \rightarrow data \neq x$
        $count = count + 1$
        $cur = cur \rightarrow link$
    $if\ cur = NULL$
        $return - 1$
    $else$
        $return\ count$
```

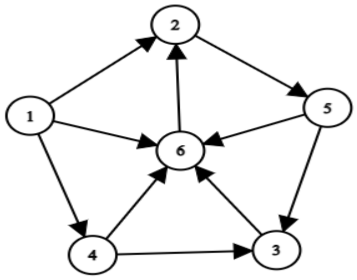
7. Is the following tree an AVL tree or not? If not convert into AVL tree.



It is not an AVL tree since balance factor of 32 is 2. After applying Left Rotation on 19 and Right Rotation on 32, it becomes AVL tree.



8. Represent the following graph as adjacency matrix:



	1	2	3	4	5	6	Out Degree
1	0	1	0	1	0	1	3
2	0	0	0	0	1	0	1
3	0	0	0	0	0	1	1
4	0	0	1	0	0	1	2
5	0	0	1	0	0	1	2
6	0	1	0	0	0	0	1
In Degree	0	2	2	1	1	4	

9. Write the contents of the following array after first partition when applying quicksort. Take last element of the array as partitioning element.

	1	2	3	4	5	6	7	8	9	10	11	12
A	65	32	45	77	30	29	11	8	20	54	85	41

Swap 65 & 20	20	32	45	77	30	29	11	8	65	54	85	41
Swap 45 & 8	20	32	8	77	30	29	11	45	65	54	85	41
Swap 77 & 11	20	32	8	11	30	29	77	45	65	54	85	41

Swap 77 & 41 **(**20 32 8 11 30 29**)** **41** **(**45 65 54 85 77**)**

10. What are the types of file organization methods?
    i. Sequential File Organization
    ii. Indexed Sequential File Organization
    iii. Direct (or) Random File Organization

PART – B

Answer any TWO questions **(2 x 10 = 20)**

11. Write the algorithm for converting an infix expression into postfix expression
    The in-stack (isp) and in-coming (icp) priorities of the operators are given as follows:

Symbol	ISP	ICP
(	0	4
$+,-$	1	1
$*,/$	2	2
$**$	3	4

```
$\boldsymbol{Algorithm\ POSTFIX(E)}$
// $To\ convert\ an\ infix\ expression\ E\ into\ its\ equivalent\ Postfix\ Expression$
$P =''$
$k = 1$
$CreateStack(S)$
$PUSH(S,'(')$
$for\ i = 1\ to\ E.length$
    $x = E[i]$
    $if\ x\ is\ an\ operand$
        $P[k] = x$
        $k = k + 1$
    $else\ if\ x = '('$
        $PUSH(S,'(')$
    $else\ if\ x = ')'$
        $while\ PEEK(S) \neq '('$
            $t = POP(S)$
            $P[k] = t$
            $k = k + 1$
        $POP(S)$
    $else$
        $while\ ISP(PEEK(S)) \geq ICP(x)$
            $t = POP(S)$
        $P[k] = t$
        $k = k + 1$
    $PUSH(S, x)$
$while\ not\ ISEMPTY(S)$
    $t = POP(S)$
    $P[k] = t$
    $k = k + 1$
$return\ P$
```

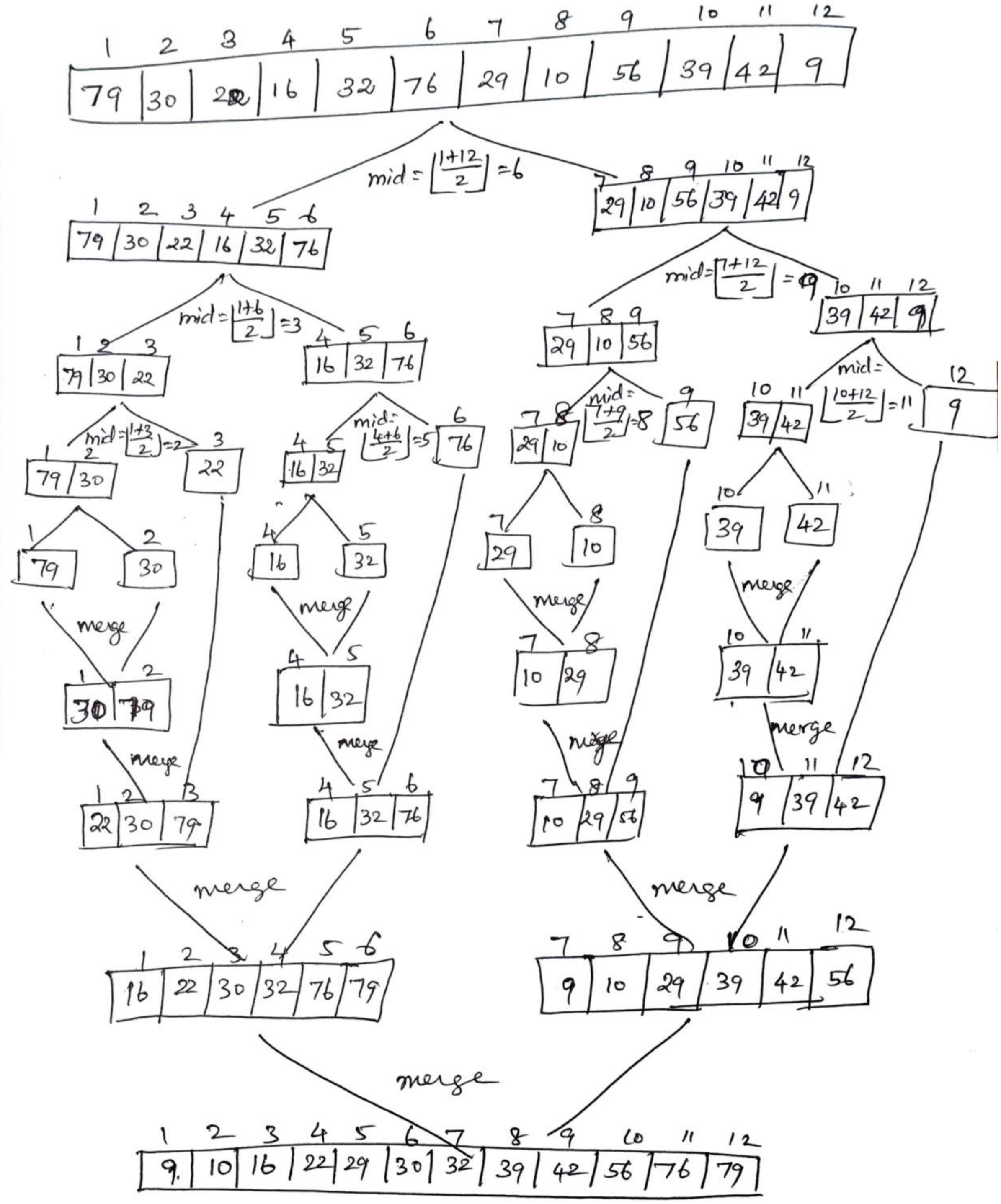
12. Write the algorithm for finding inorder predecessor and inorder successor in a threaded binary tree. Also write the non-recursive algorithm for inorder traversal of threaded binary tree.

```
$Algorithm\ TINPRED(HEAD, T)$
$P = T \rightarrow lchild$
$if\ T \rightarrow ltbit = 1$
    $return\ P$
$else$
    $while\ P \rightarrow rtbit = 0$
        $P = P \rightarrow rchild$
    $return\ P$
```

```
$Algorithm\ TINSUCC(HEAD, T)$
$S = T \rightarrow rchild$
$if\ T \rightarrow rtbit = 1$
    $return\ S$
$else$
    $while\ S \rightarrow ltbit = 0$
        $S = S \rightarrow lchild$
    $return\ S$
```

```
$Algorithm\ TINORDER(HEAD)$
$T = HEAD$
$while\ T \neq HEAD$
    $T = TINSUCC(T)$
    $if\ T = HEAD$
        $return$
    $print\ T \rightarrow data$
```

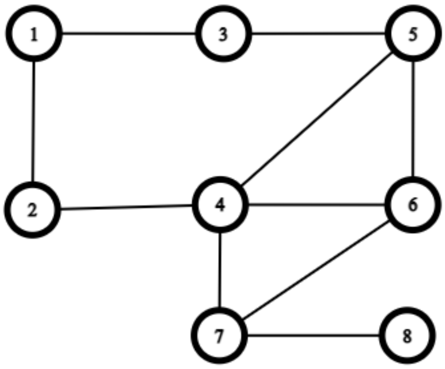
13. Sort the following array using merge sort: 79, 30, 22, 16, 32, 76, 29, 10, 56, 39, 42, 9



PART – C

Answer all the questions **(1 x 10 = 10)**

5. Represent the following graph as adjacency list and perform breadth first traversal.



Adjacency List Representation

	Name	d	Visited	eptr
1	1	0	T	→ 2 → 3
2	2	~~∅~~ 1	~~F~~T	→ 1 → 4
3	3	~~∅~~1	~~F~~T	→ 1 → 5
4	4	~~∅~~2	~~F~~T	→ 2 → 5 → 6 → 7
5	5	~~∅~~2	~~F~~T	→ 3 → 4 → 6
6	6	~~∅~~3	~~F~~T	→ 4 → 5 → 7
7	7	~~∅~~3	~~F~~T	→ 4 → 6 → 8
8	8	~~∅~~4	~~F~~T	→ 7

Let Source S = 1.

Q	~~1~~	~~2~~	~~3~~	~~4~~	~~5~~	~~6~~	~~7~~	~~8~~

$u = 1$ $v = 2, 3$

$2.d = 1.d + 1 = 0 + 1 = 1$, Insert 2 into Q

$3.d = 1.d + 1 = 0 + 1 = 1$, Insert 3 into Q

$u = 2$ $v = \cancel{1}, 4$

$4.d = 2.d + 1 = 1 + 1 = 2$, Insert 4 into Q u = 3 v = ~~1~~, 5

5.d = 3.d + 1 = 1 + 1 = 2 , Insert 5 into Q

u = 4 v = ~~2~~, ~~5~~, 6, 7

6.d = 4.d + 1 = 2 + 1 = 3 , Insert 6 into Q

7.d = 4.d + 1 = 2 + 1 = 3 , Insert 7 into Q

u = 5 v = ~~3~~, ~~4~~, ~~6~~

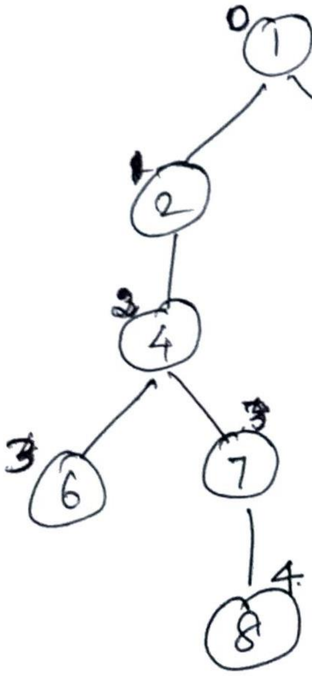
u = 6 v = ~~4~~, ~~5~~, ~~7~~

u = 7 v = ~~4~~, ~~6~~, 8

8.d = 7.d + 1 = 3 + 1 = 4 , Insert 8 into Q

u = 8 v = ~~7~~

Breadth First Tree


0
1
1
2
1
3
2
4
2
5
3
6
3
7
4
8