

# *Department of Computer Science*

## *Gujarat University*



## *Certificate*

Roll No: 10

Seat No: \_\_\_\_\_

This is to certify that Mr./Ms. Pradip S Karmakar student of MCA Semester – III has duly completed his/her term work for the semester ending in December 2020, in the subject of Data Structures (DS) towards partial fulfillment of his/her Degree of Masters in Computer Applications.

Date of Submission  
11 - December - 2020

Internal Faculty

Head of Department

Department Of Computer Science  
Rollwala Computer Centre  
Gujarat University

MCA – III

**Subject: - Data Structures (DS)**

**Name: - Pradip S Karmakar**

**Roll No.: - 10**

**Exam Seat No.: - \_\_\_\_\_**

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Q1 Infix to Postfix & prefix

$$\textcircled{1} (a+b)*c$$

→ Postfix : ab+c\*

→ Prefix : \*+abc

$$\textcircled{2} (A+(B\times C))$$

→ Postfix : ABC\*+

→ Prefix : +A\*BC

$$\textcircled{3} (x+y+z)* (A+B-C)$$

→ Postfix : XY+Z+AB+C-\*

→ Prefix : \*++XYZ-ABC

$$\textcircled{4} ((A/B)-C)+(D\times E)$$

→ Postfix : AB/C-D-E\*+

→ Prefix : +-/ABC\*DE

$$\textcircled{5} (A+B+C/D)* (E-F\times G)$$

→ Postfix : AB+CD/EF-G\*-\*

→ Prefix : \*++AB/CD-E\*FG

$$\textcircled{6} \quad (A/B/C) + (D * E - F)$$

→ Postfix : AB/C/DE \* + F -

→ Prefix : - + / / ABC \* DEF

$$\textcircled{7} \quad (X * Y * Z * W) - (A + B * C - D)$$

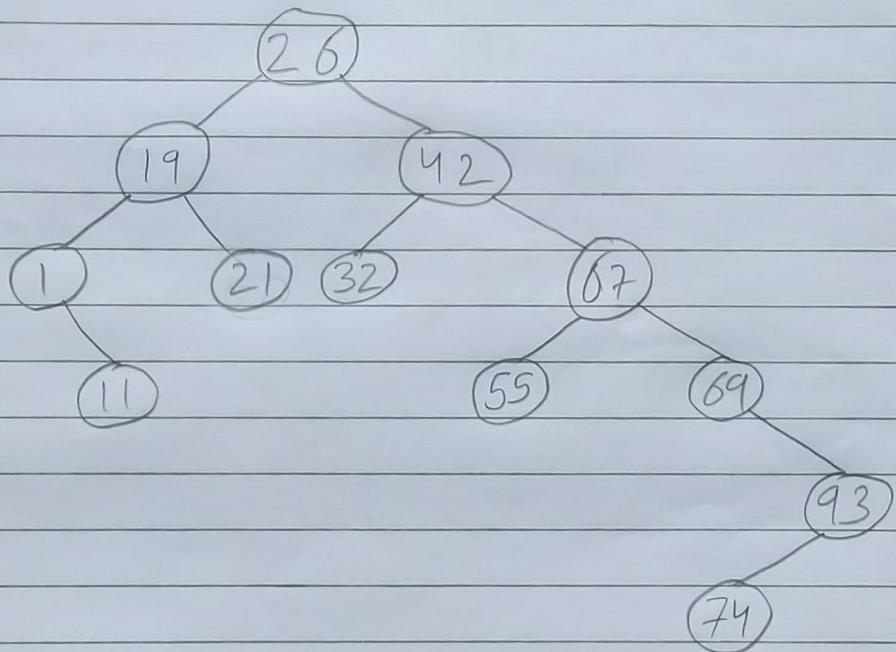
→ Postfix : XY2W \*\*\* ABC \* + d - -

→ Prefix : - \*\*\* XY2W - + A \* BC

Q2

Create binary search tree.

- ① 26, 19, 42, 67, 21, 1, 69, 55, 93, 74, 32, 11

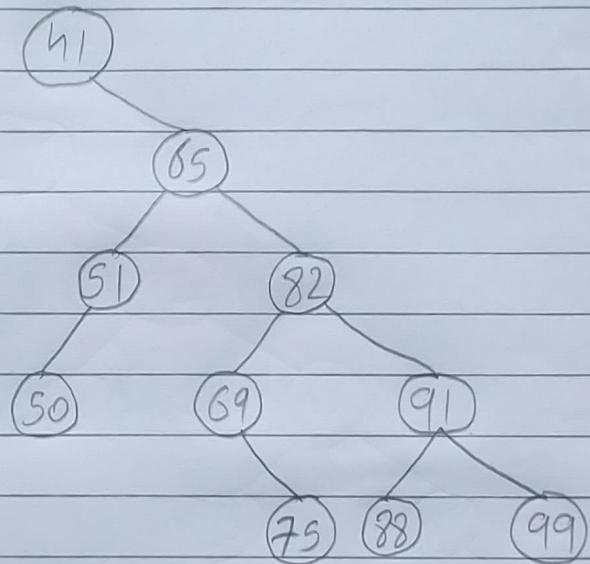


→ Inorder: - 1, 11, 19, 21, 26, 32, 42, 55, 67,  
69, 74, 93

→ Preorder: - 26, 19, 1, 11, 21, 42, 32, 67, 55, 69,  
93, 74

→ Postorder: - 11, 1, 21, 19, 32, 55, 74, 93, 69, 67,  
42, 26.

Q) 41, 65, 82, 91, 51, 50, 69, 75, 88, 99

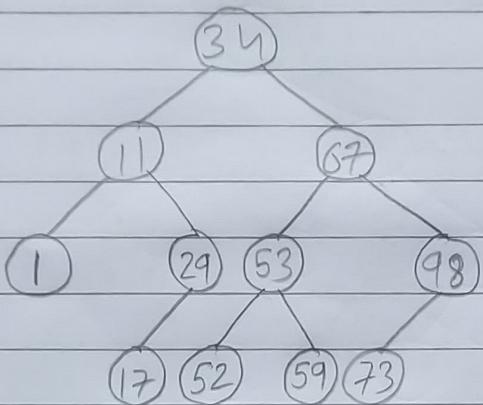


Inorder :- 41, 50, 51, 65, 69, 75, 82, 88, 91, 99

Preorder :- 41, 65, 51, 50, 82, 69, 75, 91, 88, 99

Postorder :- 50, 51, 75, 69, 88, 99, 91, 82, 65, 41

③ 34, 11, 67, 98, 1, 73, 53, 29, 52, 17, 59



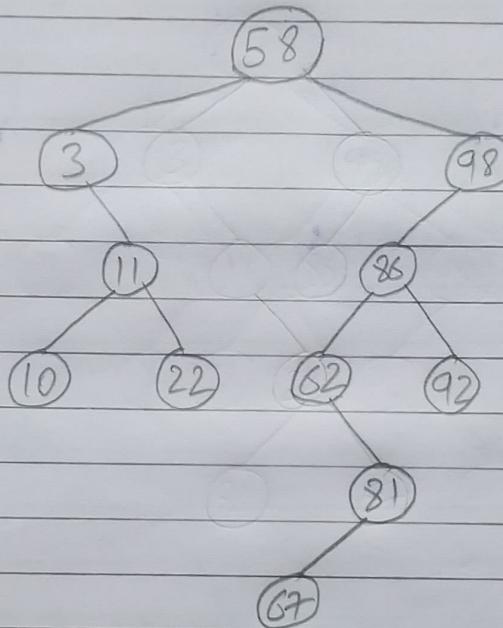
In order :- 1, 11, 17, 29, 34, 52, 53, 59, 67, 73, 98

Preorder :- 34, 11, 1, 29, 17, 67, 53, 52, 59, 98, 73

Postorder :- 1, 17, 29, 11, 52, 59, 53, 73, 98, 67, 34

⑦

58, 3, 98, 11, 86, 22, 62, 67, 81, 92, 10



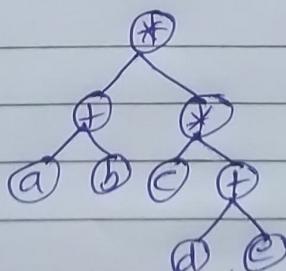
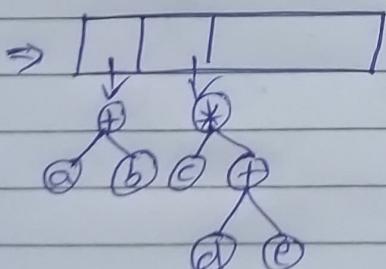
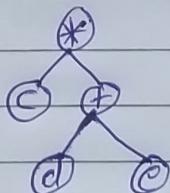
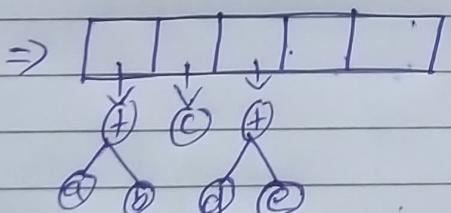
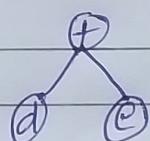
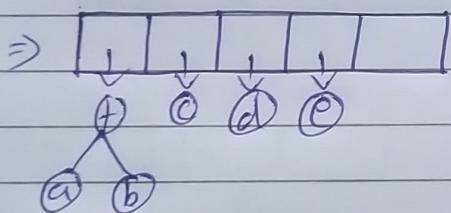
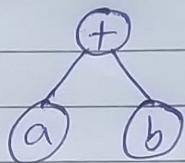
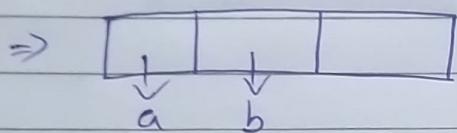
In order :- 3, 10, 11, 22, 58, 62, 67, 81, 86, 92, 98

Pre order :- 58, 3, 11, 10, 22, 98, 86, 62, 81, 67, 92

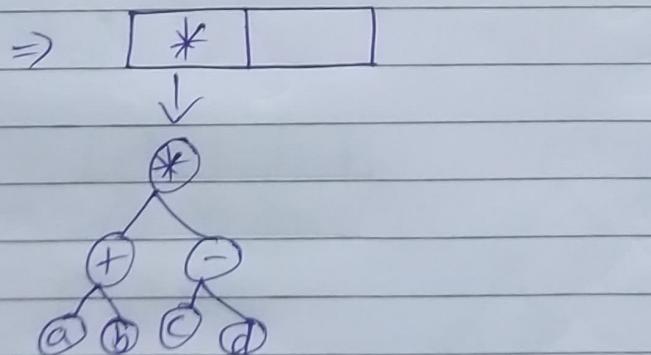
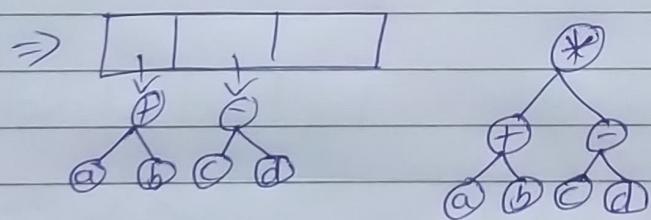
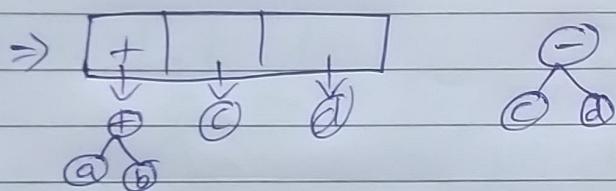
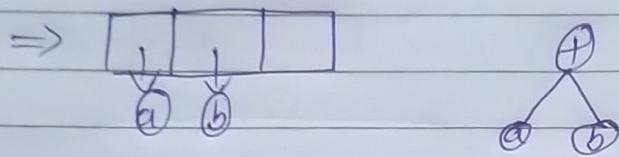
Post order :- 10, 22, 11, 3, 67, 81, 62, 92, 86, 98, 58

Q3 Create Expression Tree

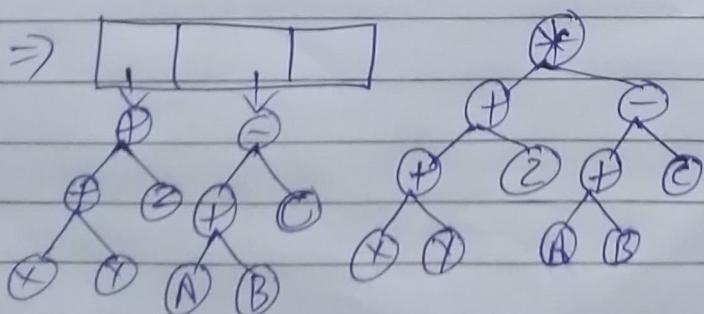
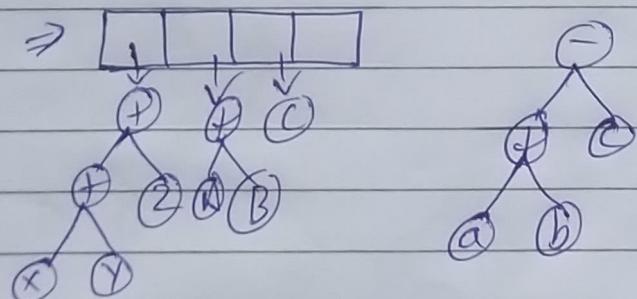
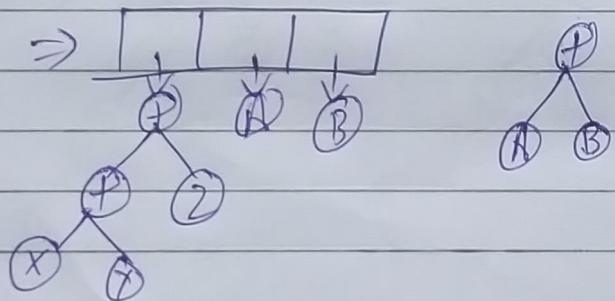
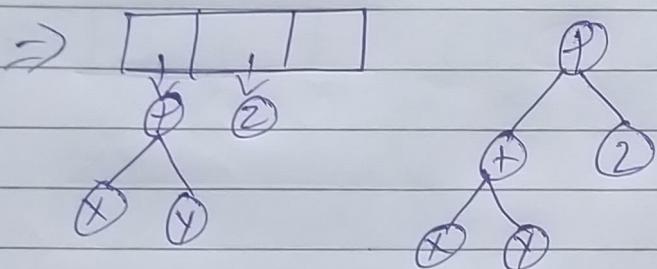
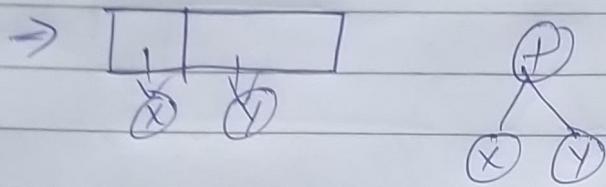
①  $ab + cde + **$



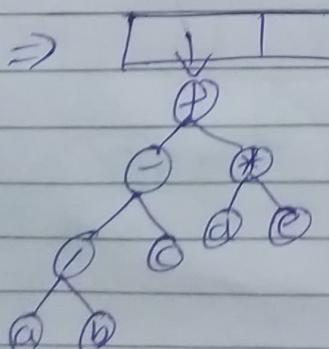
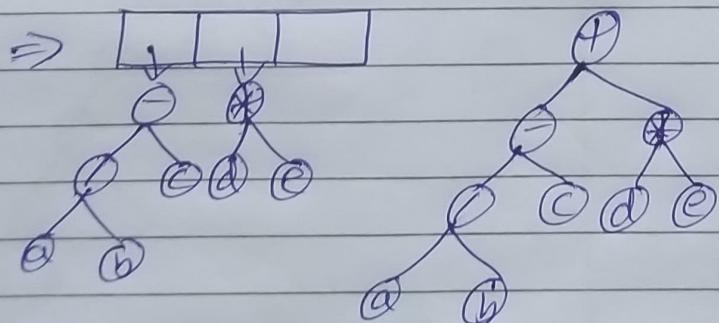
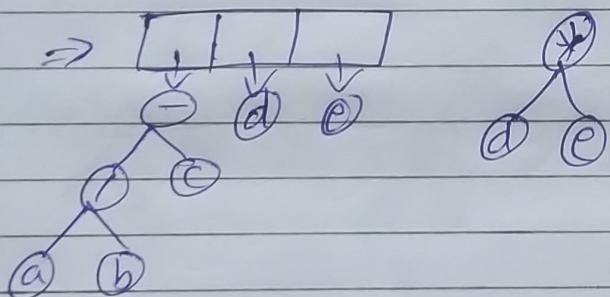
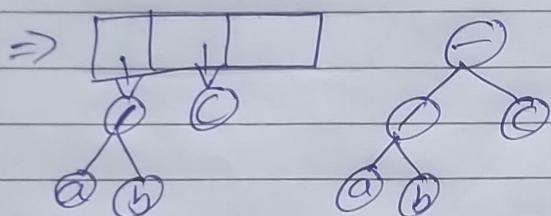
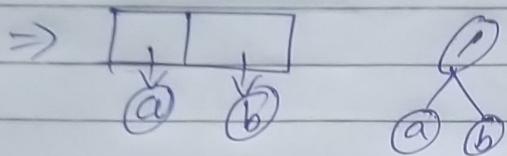
$$\textcircled{2} \quad (a+b) * (c-d) \Rightarrow ab + cd - *$$



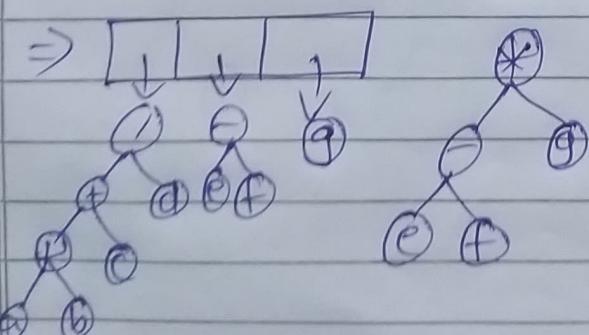
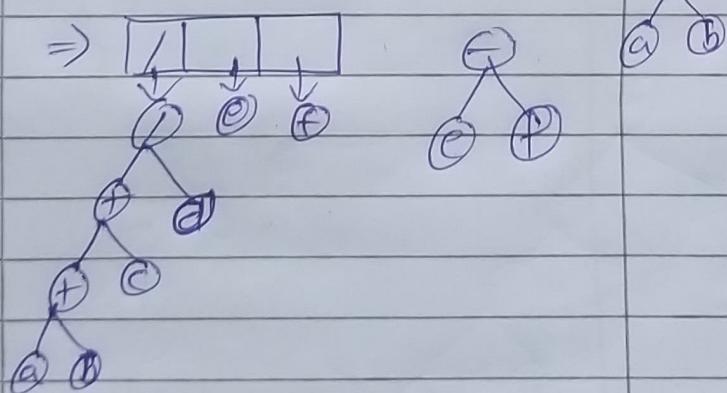
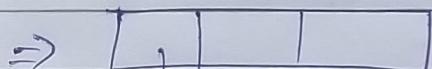
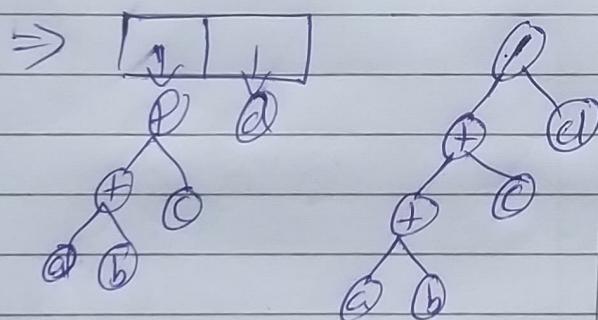
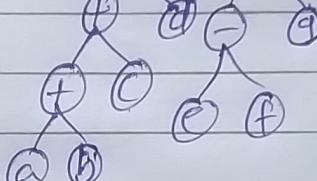
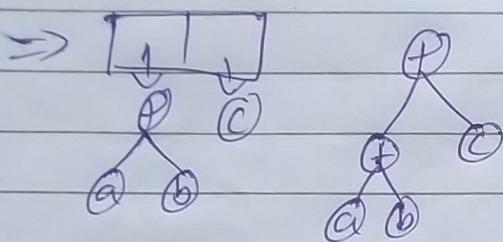
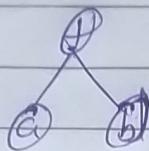
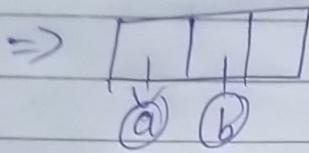
$$\textcircled{3} \quad X \times + 2 + AB + C - *$$



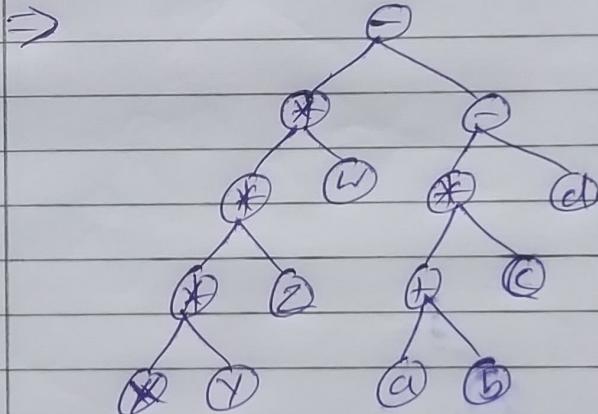
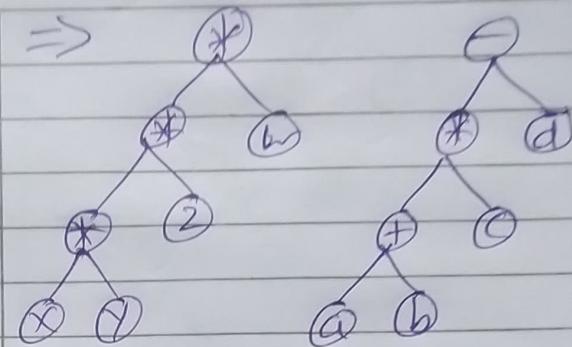
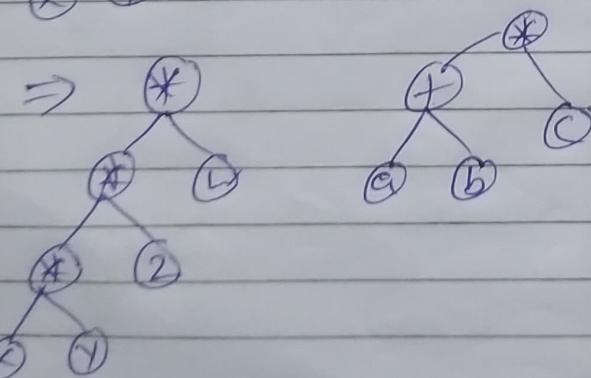
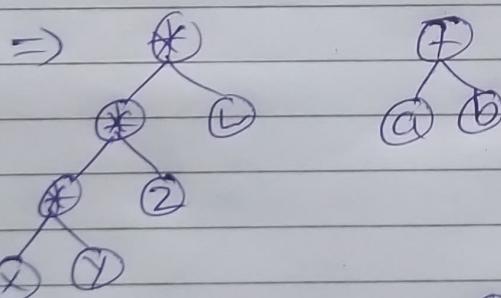
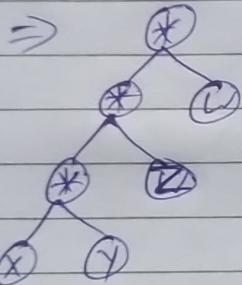
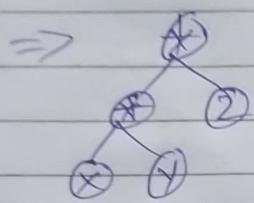
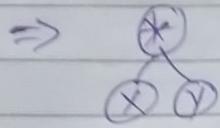
(4)  $ab/c - de * +$



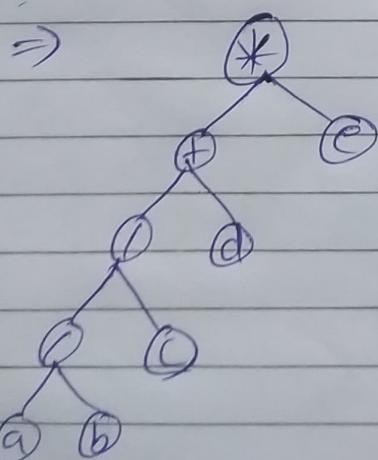
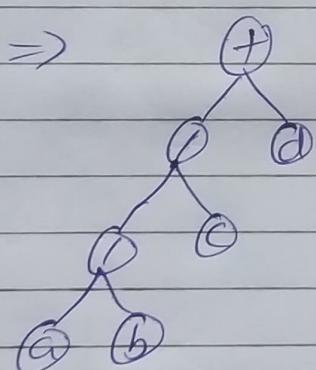
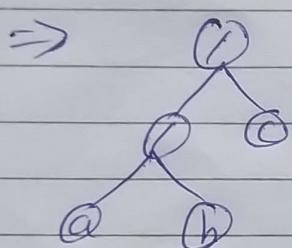
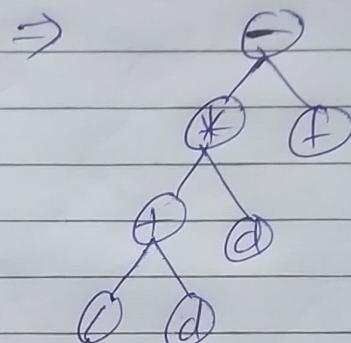
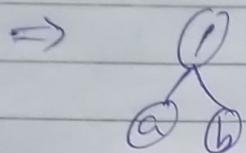
⑤  $ab + c + d / ef - g * *$



⑥  $xy * 2 * w * ab + c * d - -$

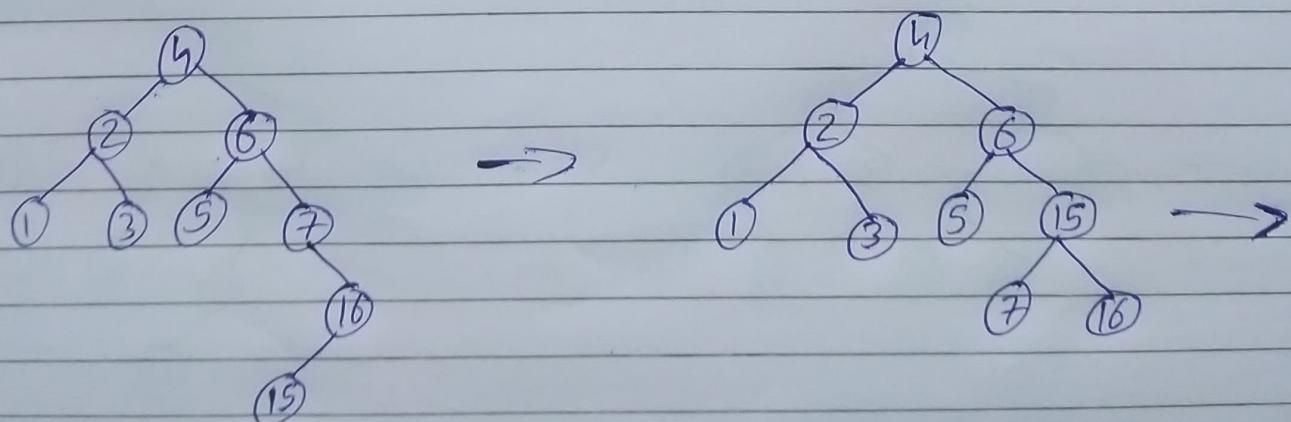
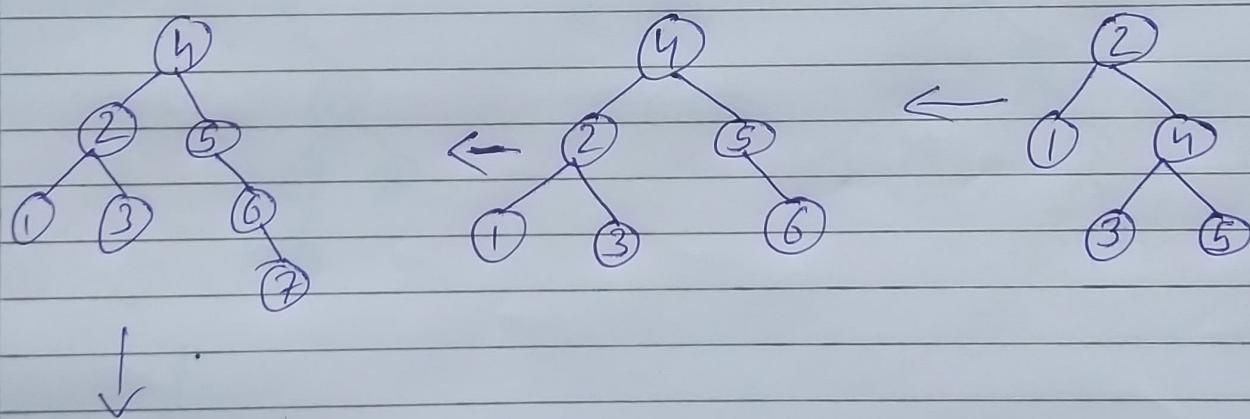
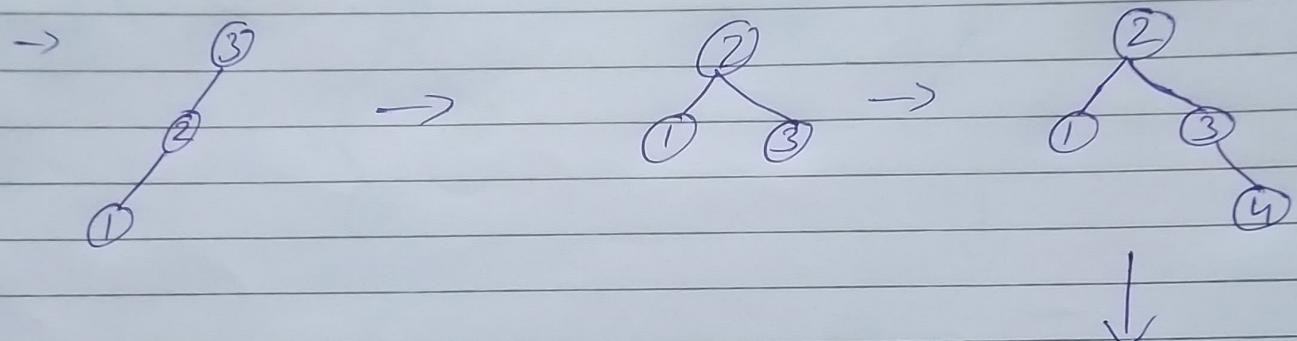


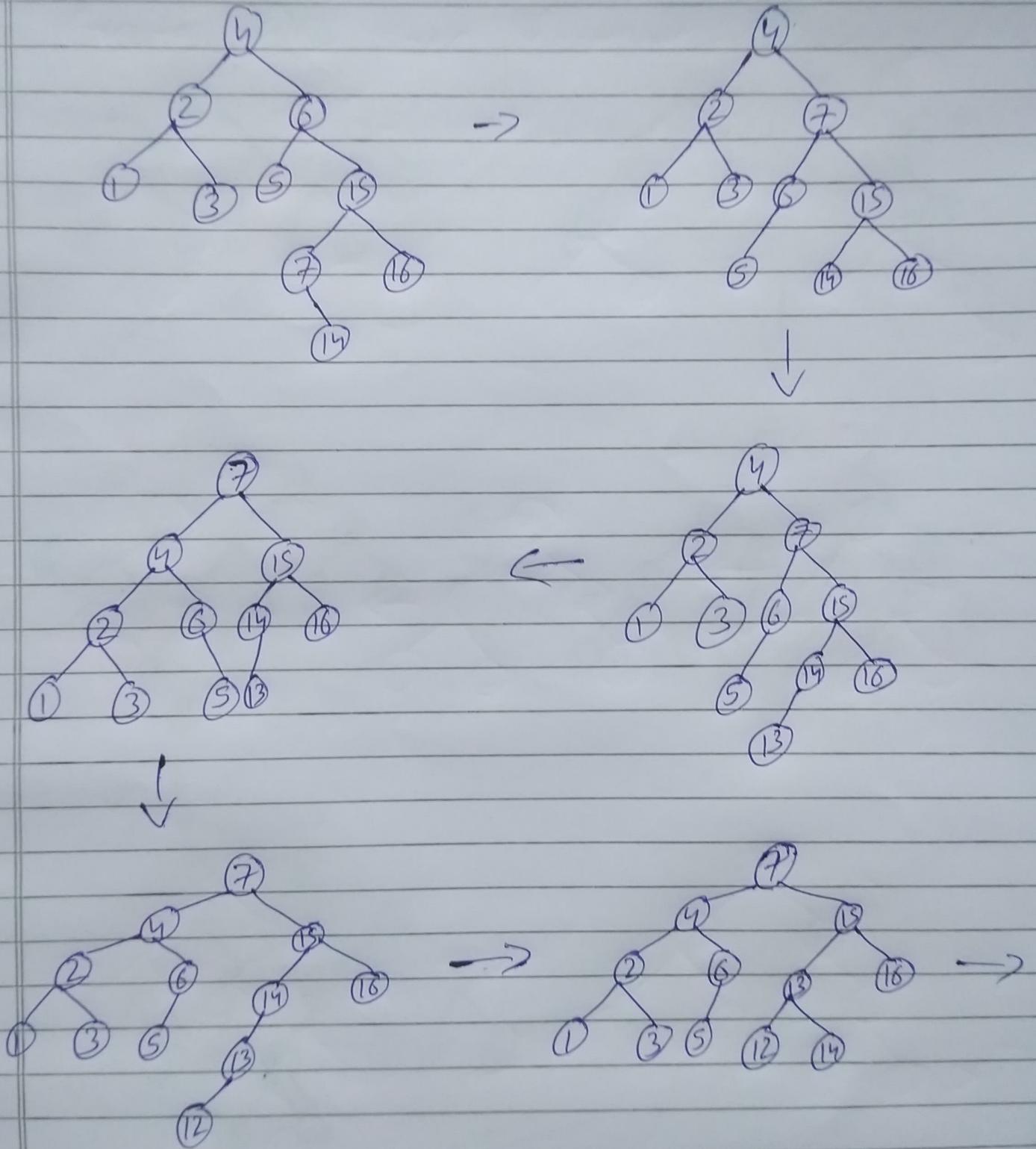
⑦  $ab/c/d + e*f -$

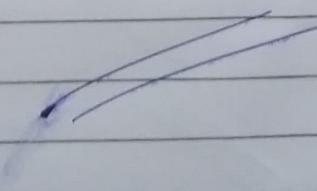
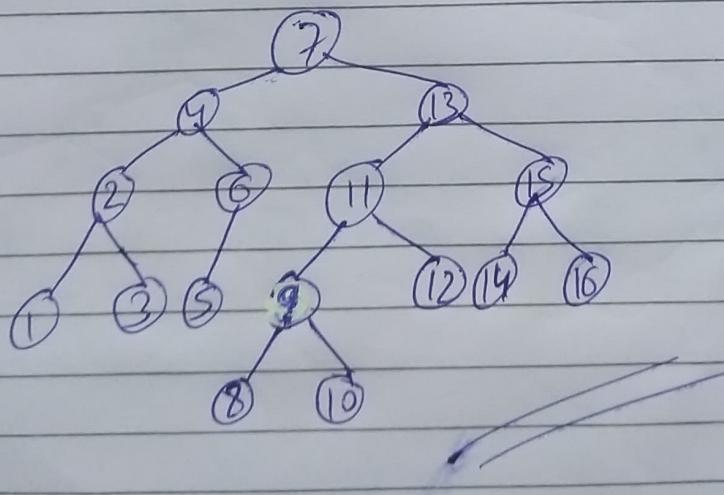
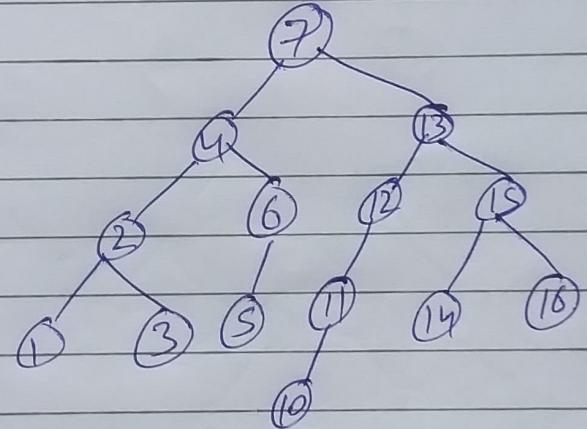
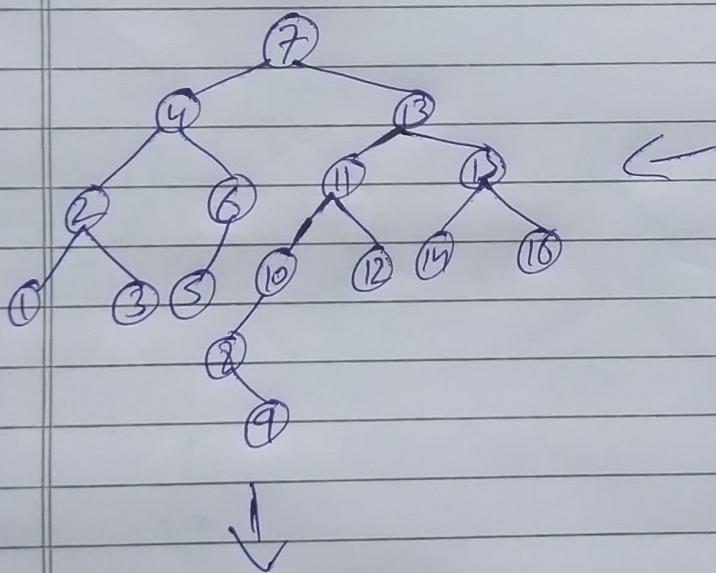
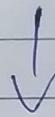
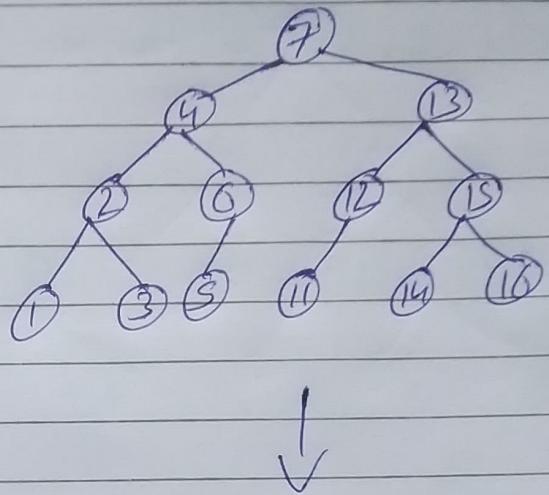
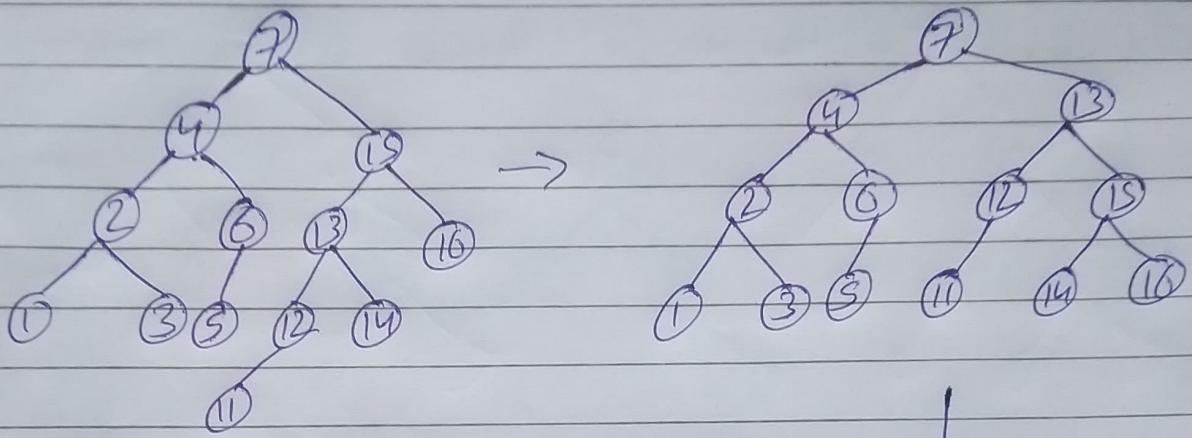


Q4 Create AVL tree from the following data

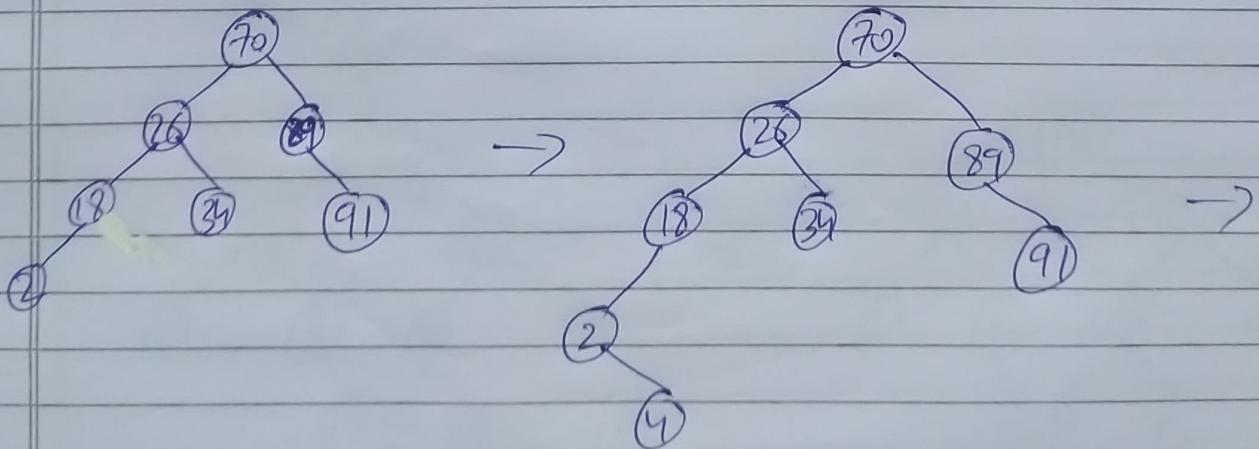
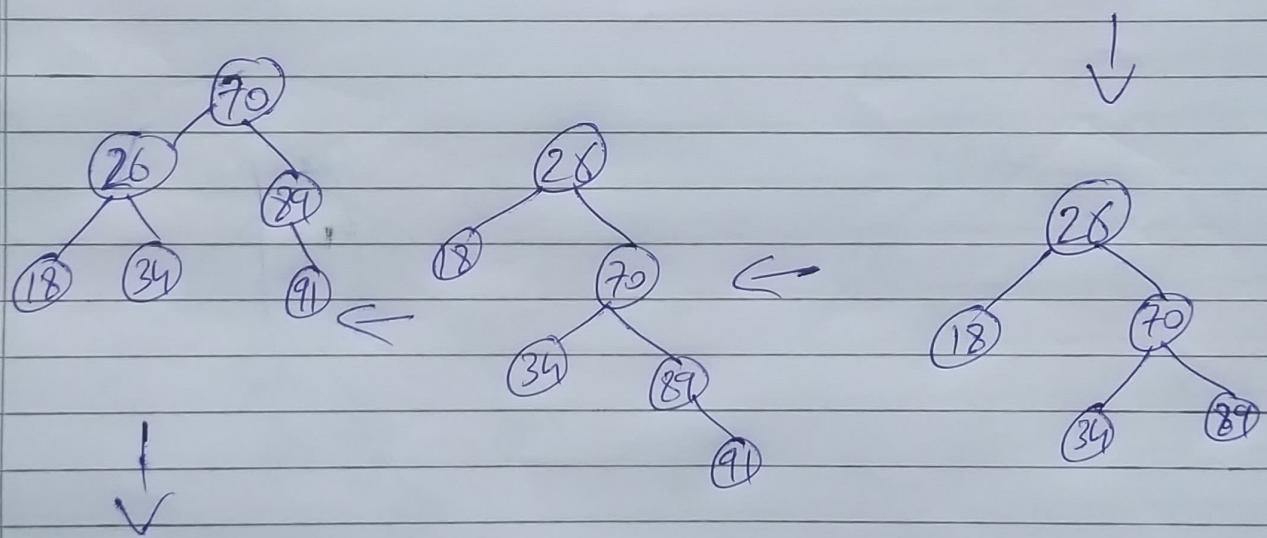
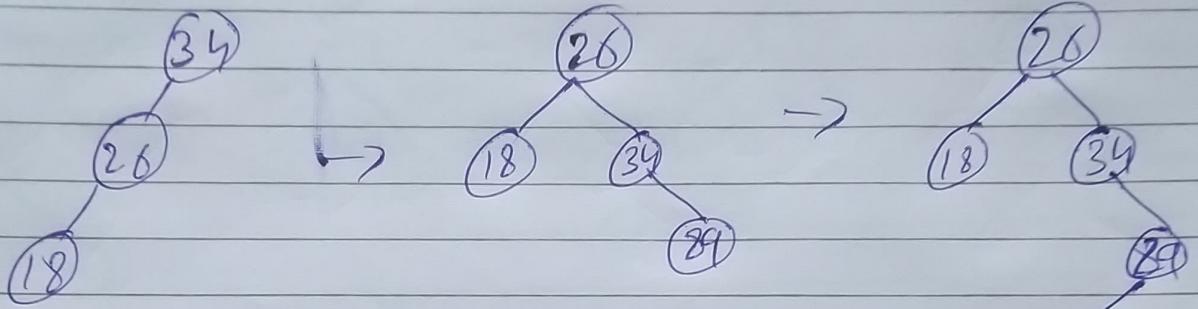
- ① 3, 2, 1, 4, 5, 6, 7, 16, 15, 14, 13, 12, 11, 10, 8, 9

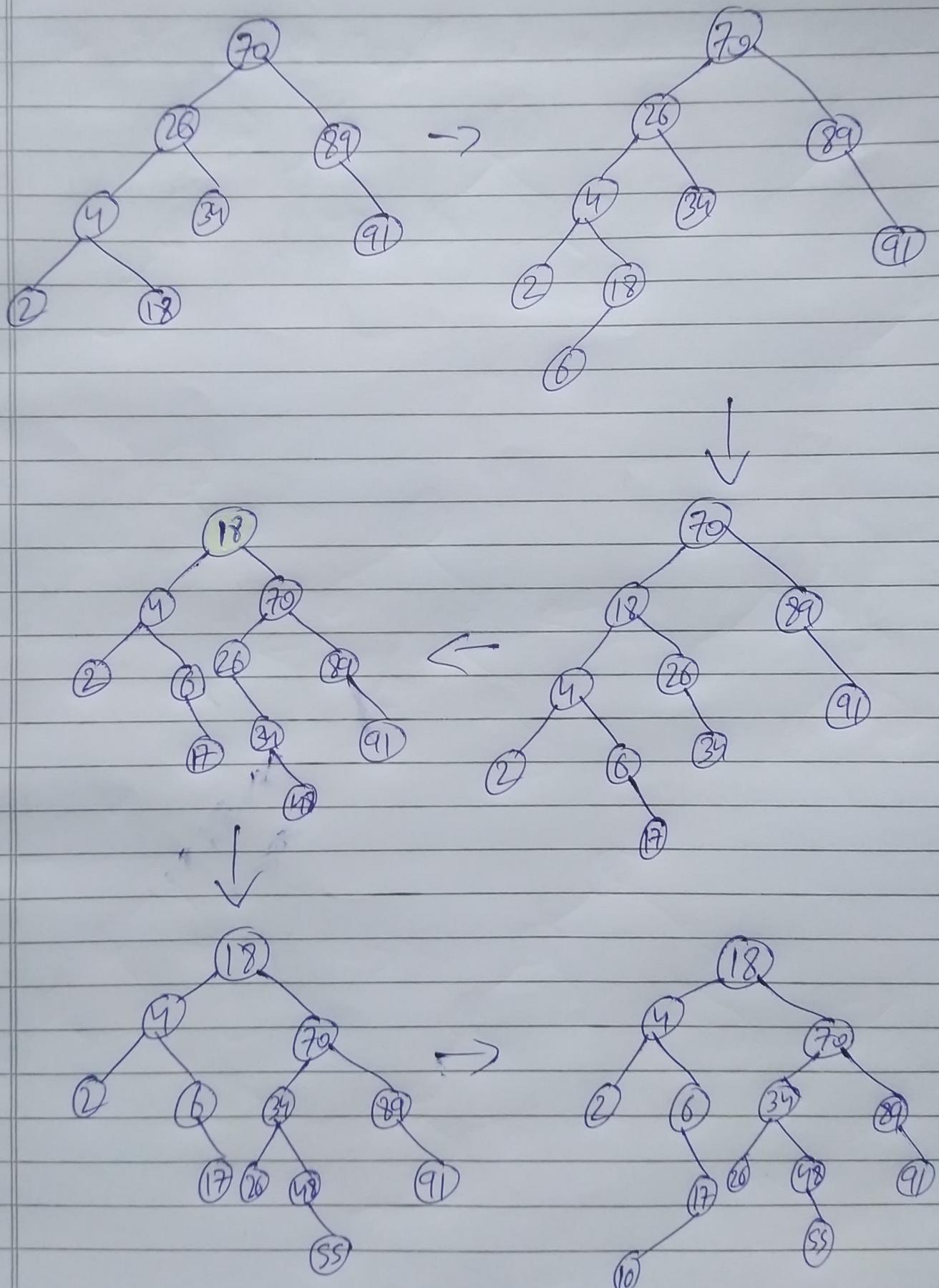


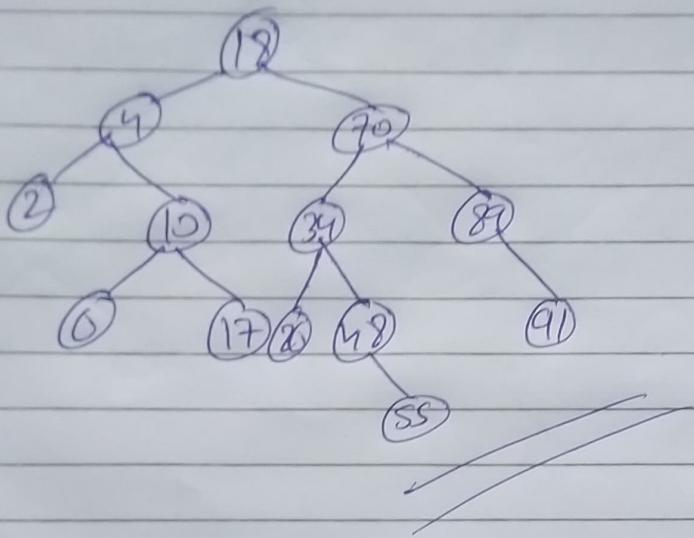




② 34, 26, 18, 89, 70, 91, 2, 4, 6, 17, 48, 55, 10

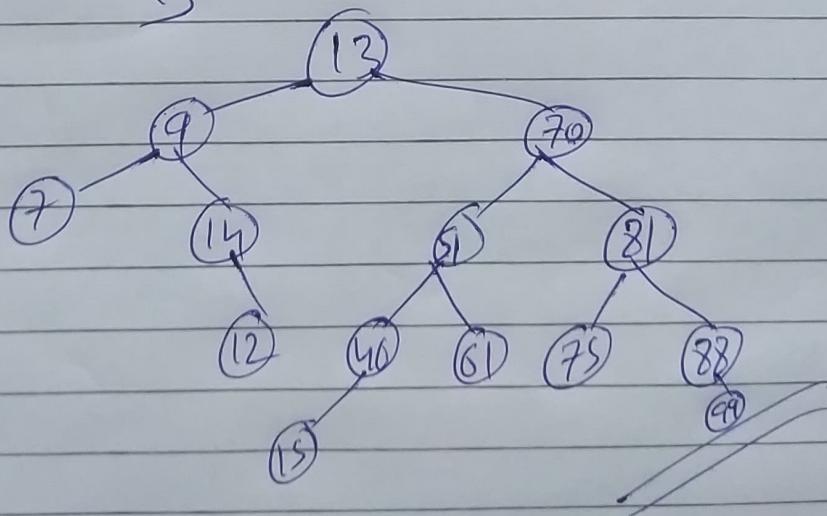
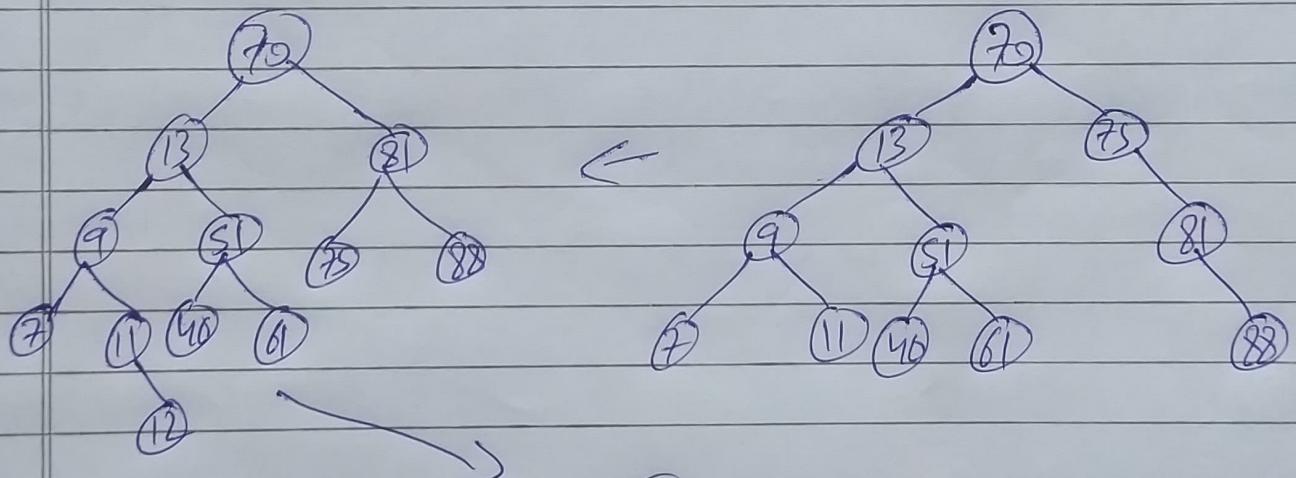
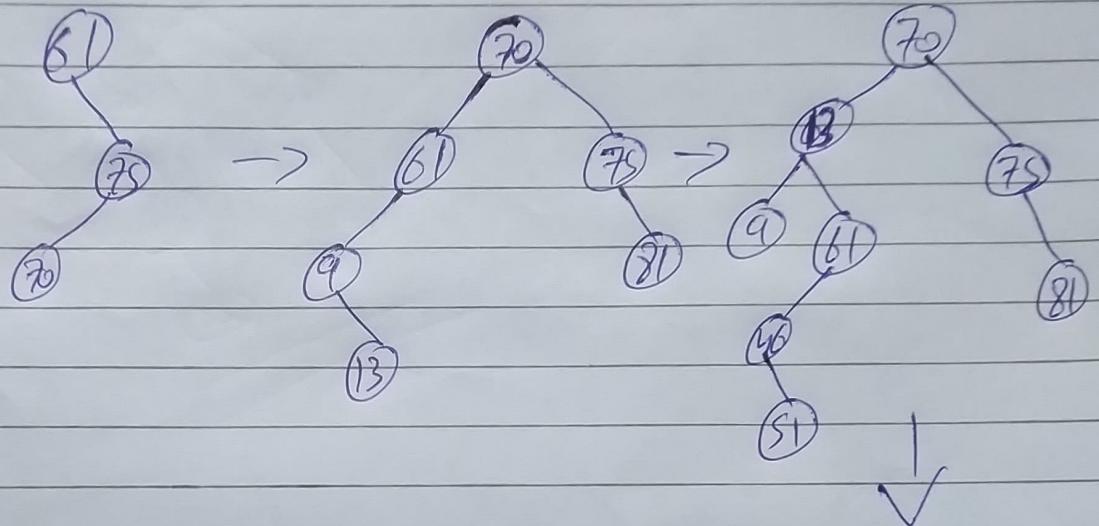






(3)

61, 75, 70, 81, 9, 13, 46, 51, 11, 7, 88, 99, 12, 15



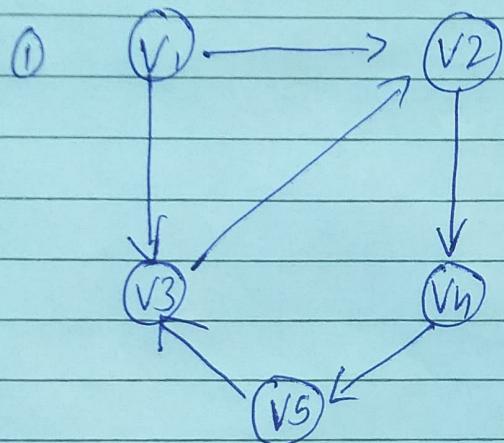
# Assignment -2

Page No. :

Date .

## Graph

### ① Unweighted shortest Path Algorithm



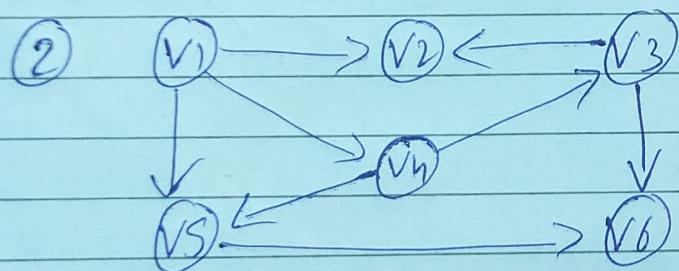
initial state

V	Known	dv	PV
V <sub>1</sub>	0	0	0
V <sub>2</sub>	0	$\infty$	0
V <sub>3</sub>	0	$\infty$	0
V <sub>n</sub>	0	$\infty$	0
V <sub>S</sub>	0	$\infty$	0

V	Known	dv	PV	V	Known	dv	PV
V <sub>1</sub>	1	0	0	V <sub>1</sub>	1	0	0
V <sub>2</sub>	0	1	V <sub>1</sub>	V <sub>2</sub>	1	1	V <sub>1</sub>
V <sub>3</sub>	0	1	V <sub>1</sub>	V <sub>3</sub>	0	1	V <sub>1</sub>
V <sub>n</sub>	0	$\infty$	0	V <sub>n</sub>	0	2	V <sub>n</sub>
V <sub>S</sub>	0	$\infty$	0	V <sub>S</sub>	0	0	0

V	Known	dv	P	V	Known	dv	PV
V <sub>1</sub>	1	0	0	V <sub>1</sub>	1	0	0
V <sub>2</sub>	1	1	V <sub>1</sub>	V <sub>2</sub>	1	1	V <sub>1</sub>
V <sub>3</sub>	1	1	V <sub>1</sub>	V <sub>3</sub>	1	1	V <sub>1</sub>
V <sub>n</sub>	0	2	V <sub>n</sub>	V <sub>n</sub>	1	2	V <sub>n</sub>
V <sub>S</sub>	0	$\infty$	0	V <sub>S</sub>	1	3	V <sub>n</sub>

v	known	dv	PV
$v_1$	1	0	0
$v_2$	1	1	$v_1$
$v_3$	1	1	$v_1$
$v_h$	1	2	$v_h$
$v_s$	1	3	$v_h$



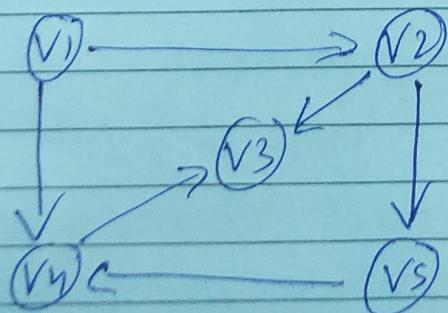
v	initial value	known	dv	PV
$v_1$	0	0	0	0
$v_2$	0	0	$\infty$	0
$v_3$	0	0	$\infty$	0
$v_h$	0	0	$\infty$	0
$v_s$	0	0	$\infty$	0
$v_6$	0	0	$\infty$	0

v	known	dv	PV	v	known	dv	PV
$v_1$	1	0	0	$v_1$	1	0	0
$v_2$	0	1	$v_1$	$v_2$	1	1	$v_1$
$v_3$	0	$\infty$	0	$v_3$	0	$\infty$	0
$v_h$	0	1	$v_1$	$v_h$	0	1	$v_1$
$v_s$	0	1	$v_1$	$v_s$	0	1	$v_1$
$v_6$	0	$\infty$	0	$v_6$	0	$\infty$	0

V	Known	dV	PV	V	Known	dV	PV
V <sub>1</sub>	1	0	0	V <sub>1</sub>	1	0	0
V <sub>2</sub>	1	1	V <sub>1</sub>	V <sub>2</sub>	1	1	V <sub>1</sub>
V <sub>3</sub>	0	2	V <sub>h</sub>	V <sub>3</sub>	0	2	V <sub>h</sub>
V <sub>h</sub>	1	1	V <sub>1</sub>	V <sub>h</sub>	1	1	V <sub>1</sub>
V <sub>S</sub>	0	1	V <sub>1</sub>	V <sub>S</sub>	1	1	V <sub>1</sub>
V <sub>6</sub>	0	$\infty$	0	V <sub>6</sub>	0	2	V <sub>S</sub>

V	Known	dV	PV	V	Known	dV	PV
V <sub>1</sub>	1	0	0	V <sub>1</sub>	1	0	0
V <sub>2</sub>	1	1	V <sub>1</sub>	V <sub>2</sub>	1	1	V <sub>1</sub>
V <sub>3</sub>	1	2	V <sub>h</sub>	V <sub>3</sub>	1	2	V <sub>h</sub>
V <sub>h</sub>	1	1	V <sub>1</sub>	V <sub>h</sub>	1	1	V <sub>1</sub>
V <sub>S</sub>	1	1	V <sub>1</sub>	V <sub>S</sub>	1	1	V <sub>1</sub>
V <sub>6</sub>	0	2	V <sub>S</sub>	V <sub>6</sub>	1	2	V <sub>S</sub>

(3)



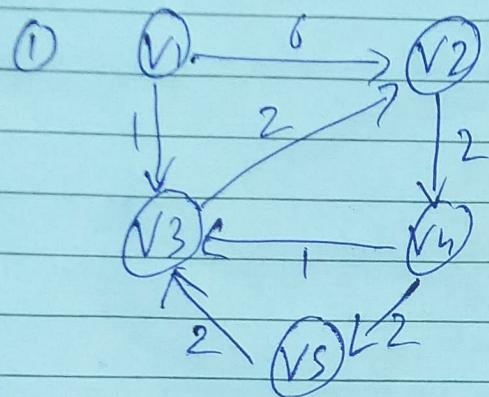
initial table

V	Known	dV	PV
V <sub>1</sub>	0	0	0
V <sub>2</sub>	0	$\infty$	0
V <sub>3</sub>	0	$\infty$	0
V <sub>h</sub>	0	$\infty$	0
V <sub>S</sub>	0	$\infty$	0

V	Known	dv	PV	V	Known	dv	PV
$v_1$	1	0	0	$v_1$	1	0	0
$v_2$	1	1	$v_1$	$v_2$	1	1	$v_1$
$v_3$	0	1	$v_1$	$v_3$	1	1	$v_1$
$v_n$	0	1	$v_1$	$v_n$	0	1	$v_1$
$v_s$	0	2	$v_2$	$v_s$	0	2	$v_2$

V	Known	dv	PV	V	Known	dv	PV
$v_1$	1	0	0	$v_1$	1	0	0
$v_2$	1	1	$v_1$	$v_2$	1	1	$v_1$
$v_3$	1	1	$v_1$	$v_3$	1	1	$v_1$
$v_n$	1	1	$v_1$	$v_n$	1	1	$v_1$
$v_s$	0	2	$v_2$	$v_s$	1	2	$v_2$

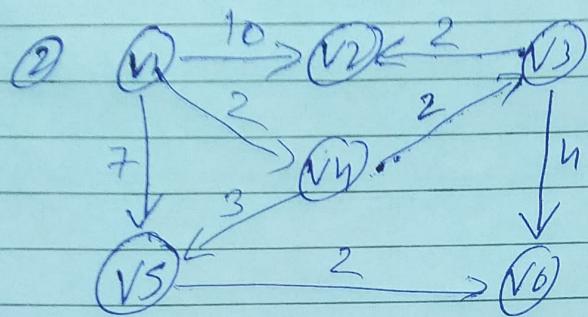
## ② Weighted shortest Path Algorithm (Dijkstra)



V	known	dv	PV
V1	0	0	0
V2	0	0	0
V3	0	$\infty$	0
V4	0	$\infty$	0
VS	0	$\infty$	0

V	known	dv	PV	V	known	dv	PV
V1	1	0	0	V1	1	0	0
V2	0	1	V1	V2	0	3	V3
V3	0	1	V1	V3	1	1	V1
V4	0	$\infty$	0	V4	0	$\infty$	0
VS	0	$\infty$	0	VS	0	$\infty$	0

V	known	dv	PV	V	known	dv	PV
V1	1	0	0	V1	1	0	0
V2	1	3	V3	V2	1	3	V3
V3	1	1	V1	V3	1	1	V1
V4	0	5	V2	V4	1	5	V2
VS	0	$\infty$	0	VS	0	7	V4

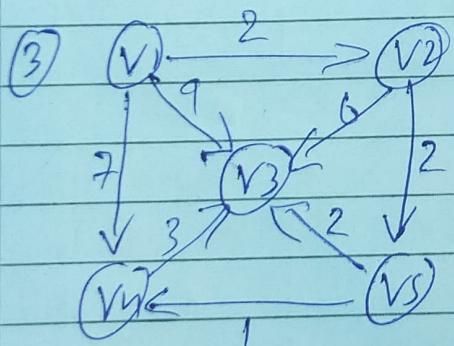


Initial table	
V	Known
V1	0
V2	0
V3	0
Vh	0
VS	0
V6	0

V	Known	dv	PV	V	Known	dv	PV
V1	1	0	0	V1	1	0	0
V2	0	10	V1	V2	0	10	V1
V3	0	$\infty$	0	V3	0	h	Vh
Vh	0	2	V1	Vh	1	2	V1
VS	0	7	V1	VS	0	5	Vh
V6	0	$\infty$	0	V6	0	$\infty$	0

V	Known	dv	PV	V	Known	dv	PV
V1	1	0	0	V1	1	0	0
V2	0	6	V3	V2	0	6	V3
V3	1	h	Vh	V3	1	h	Vh
Vh	1	2	V1	Vh	1	2	V1
VS	0	5	Vh	VS	1	5	Vh
V6	0	8	V3	V6	0	7	VS

V	Known	dV	PV	V	Known	dV	PV
V <sub>1</sub>	1	0	0	V <sub>1</sub>	1	0	0
V <sub>2</sub>	0	6	V <sub>3</sub>	V <sub>2</sub>	1	6	V <sub>3</sub>
V <sub>3</sub>	1	4	V <sub>n</sub>	V <sub>3</sub>	1	4	V <sub>n</sub>
V <sub>n</sub>	1	2	V <sub>1</sub>	V <sub>n</sub>	1	2	V <sub>1</sub>
V <sub>S</sub>	1	5	V <sub>n</sub>	V <sub>S</sub>	1	5	V <sub>n</sub>
V <sub>6</sub>	1	7	V <sub>S</sub>	V <sub>6</sub>	1	7	V <sub>S</sub>



initial table

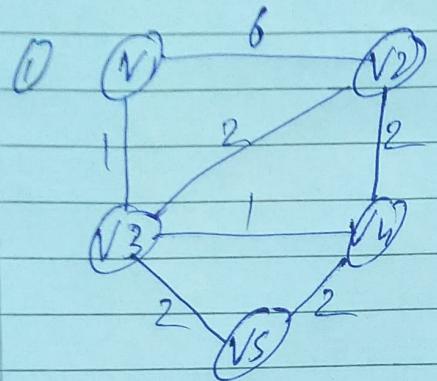
V	Known	dV	PV
V <sub>1</sub>	0	0	0
V <sub>2</sub>	0	$\infty$	0
V <sub>3</sub>	0	$\infty$	0
V <sub>n</sub>	0	$\infty$	0
V <sub>S</sub>	0	$\infty$	0

V	Known	dV	PV	V	Known	dV	PV
V <sub>1</sub>	1	0	0	V <sub>1</sub>	1	0	0
V <sub>2</sub>	0	2	V <sub>1</sub>	V <sub>2</sub>	1	2	V <sub>1</sub>
V <sub>3</sub>	0	9	V <sub>1</sub>	V <sub>3</sub>	0	6	V <sub>2</sub>
V <sub>n</sub>	0	7	V <sub>1</sub>	V <sub>n</sub>	0	7	V <sub>1</sub>
V <sub>S</sub>	0	$\infty$	0	V <sub>S</sub>	0	4	V <sub>2</sub>

V	Known	dV	PV	V	Known	dV	PV
V <sub>1</sub>	1	0	0	V <sub>1</sub>	1	0	0
V <sub>2</sub>	1	2	V <sub>1</sub>	V <sub>2</sub>	1	2	V <sub>1</sub>
V <sub>3</sub>	0	6	V <sub>2</sub>	V <sub>3</sub>	0	6	V <sub>2</sub>
V <sub>4</sub>	0	5	V <sub>3</sub>	V <sub>4</sub>	1	5	V <sub>3</sub>
V <sub>5</sub>	1	h	V <sub>2</sub>	V <sub>5</sub>	1	h	V <sub>2</sub>

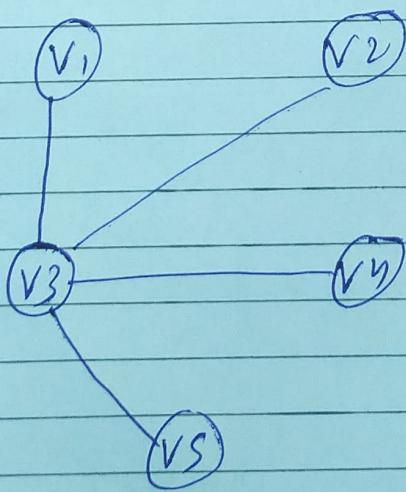
V	Known	dV	PV
V <sub>1</sub>	1	0	0
V <sub>2</sub>	1	2	V <sub>1</sub>
V <sub>3</sub>	1	6	V <sub>2</sub>
V <sub>4</sub>	1	5	V <sub>3</sub>
V <sub>5</sub>	1	h	V <sub>2</sub>

③ Krushkal's Minimum spanning Tree Algorithm

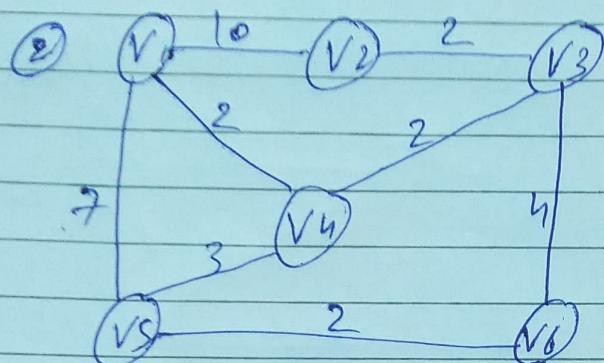


$(V_1, V_3)$   
 $(V_2, V_4)$   
 $(V_3, V_2)$   
 $(V_3, V_5)$   
 $(V_4, V_5)$   
 $(V_1, V_5)$   
 $(V_1, V_2)$

Accepted  
 Accepted  
 Accepted  
 Accepted  
 Rejected  
 Rejected  
 Rejected.

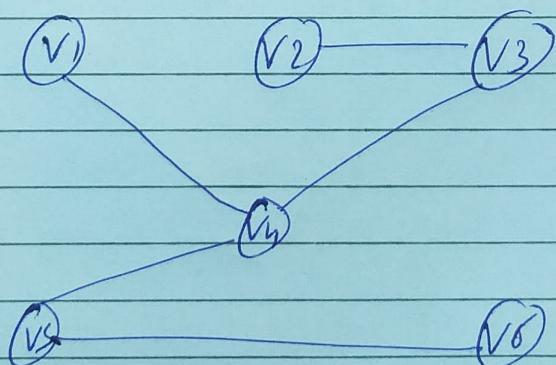


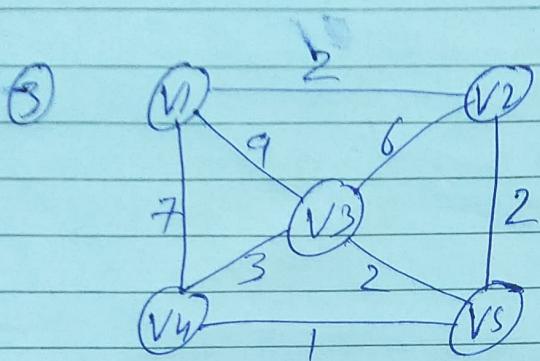
Minimum Spanning tree



$(v_2, v_3)$   
 $(v_1, v_4)$   
 $(v_4, v_3)$   
 $(v_5, v_6)$   
 $(v_5, v_4)$   
 $(v_3, v_6)$   
 $(v_1, v_5)$   
 $(v_1, v_2)$

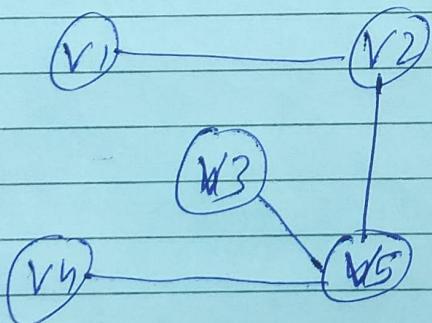
Accepted  
 Accepted  
 Accepted  
 Accepted  
 Accepted  
 Accepted  
 Rejected  
 Rejected  
 Rejected





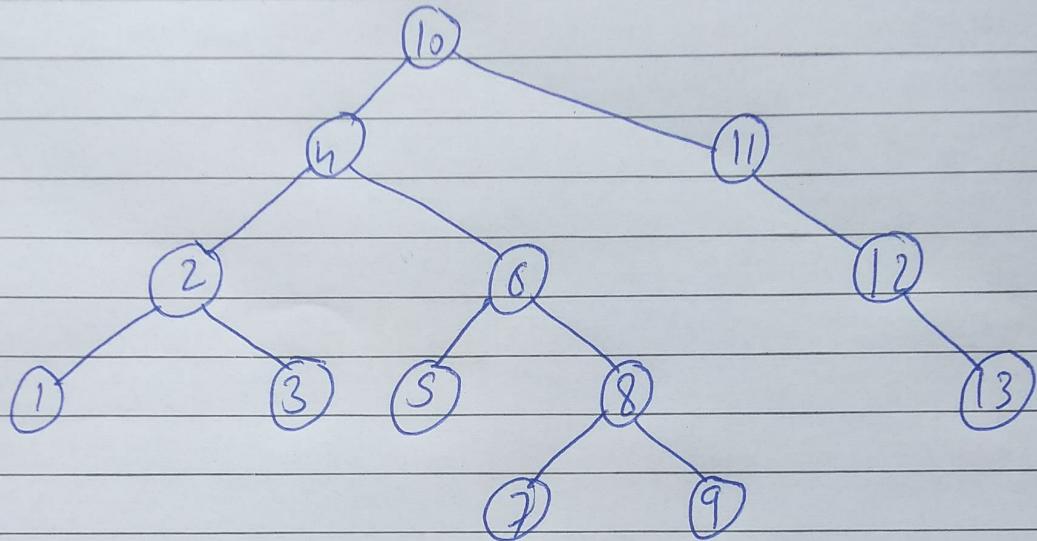
$(V_1, V_5)$   
 $(V_1, V_2)$   
 $(V_3, V_5)$   
 $(V_2, V_5)$   
 $(V_3, V_4)$   
 $(V_3, V_2)$   
 $(V_1, V_4)$

Accepted  
 Accepted  
 Accepted  
 Accepted  
 Rejected  
 Rejected  
 Rejected

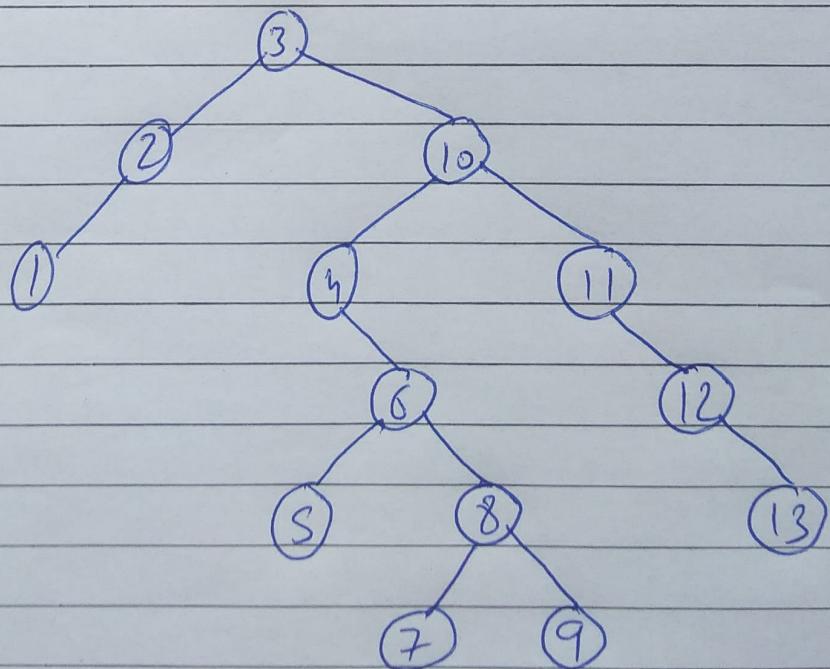


## Splay tree

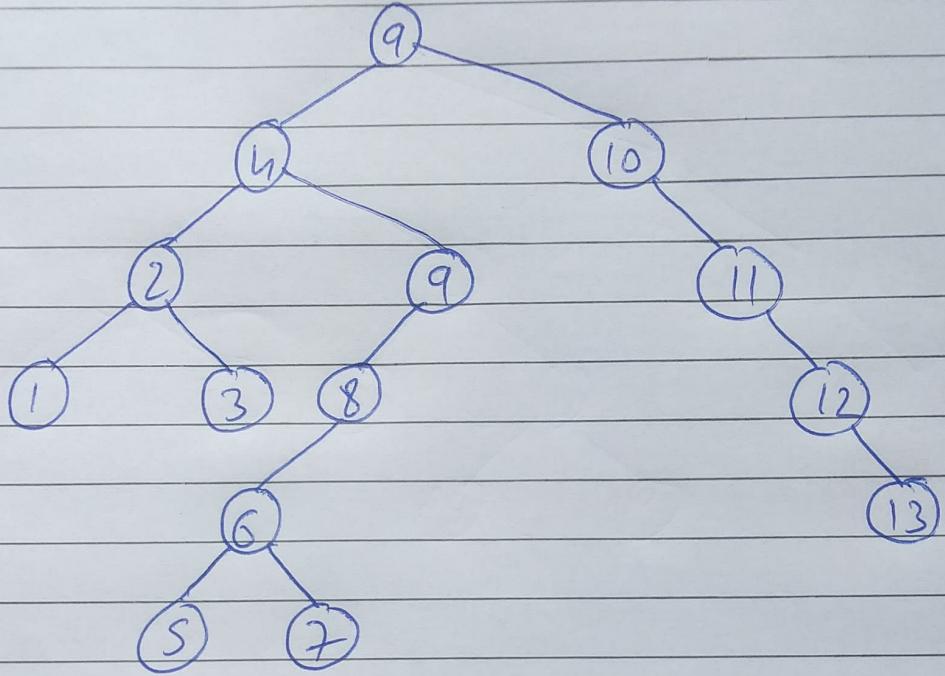
Splay tree at 3, 9, 1, 5



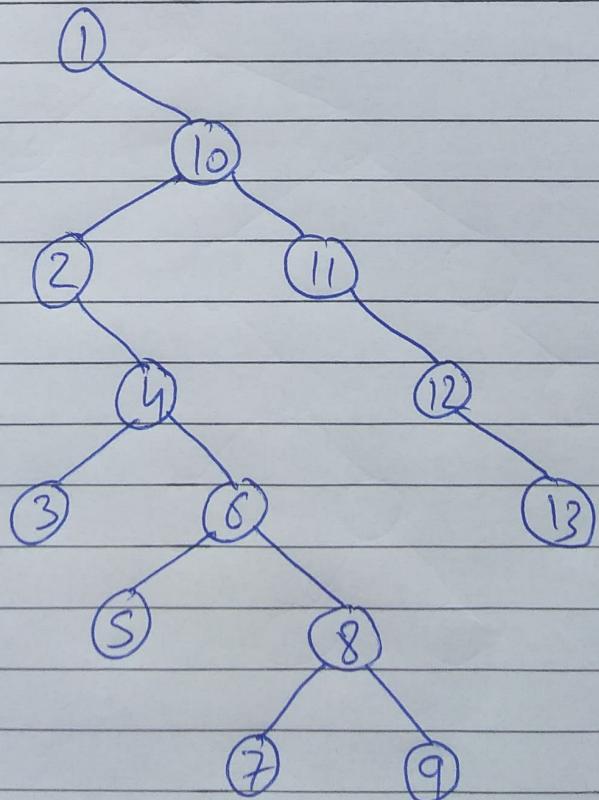
→ SPlay at ③



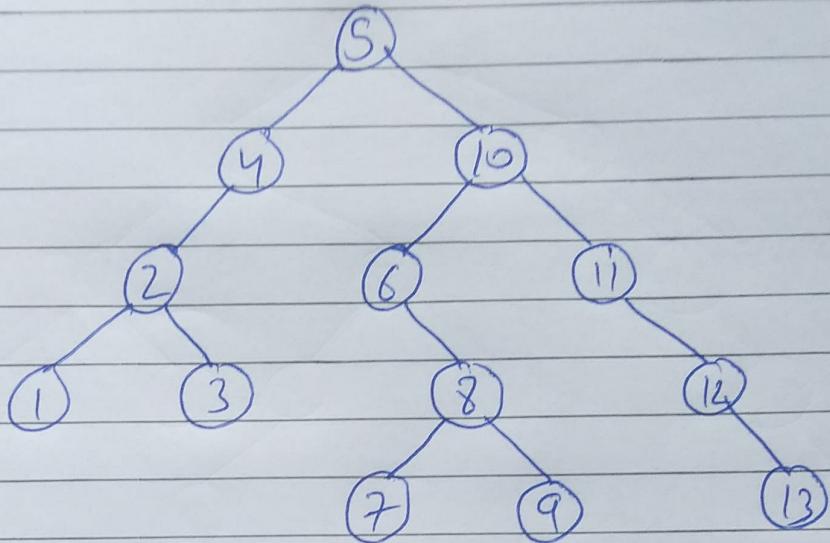
→ splay at ⑨



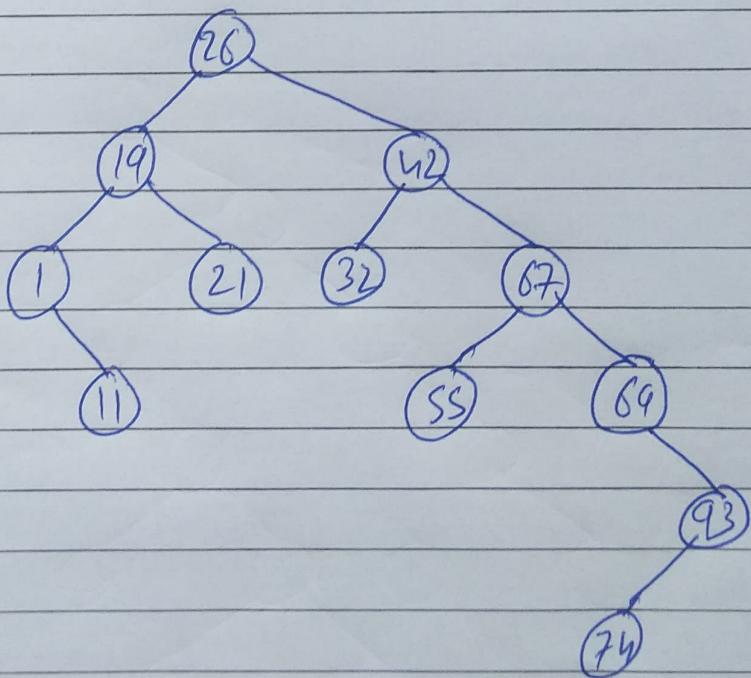
→ splay at ①



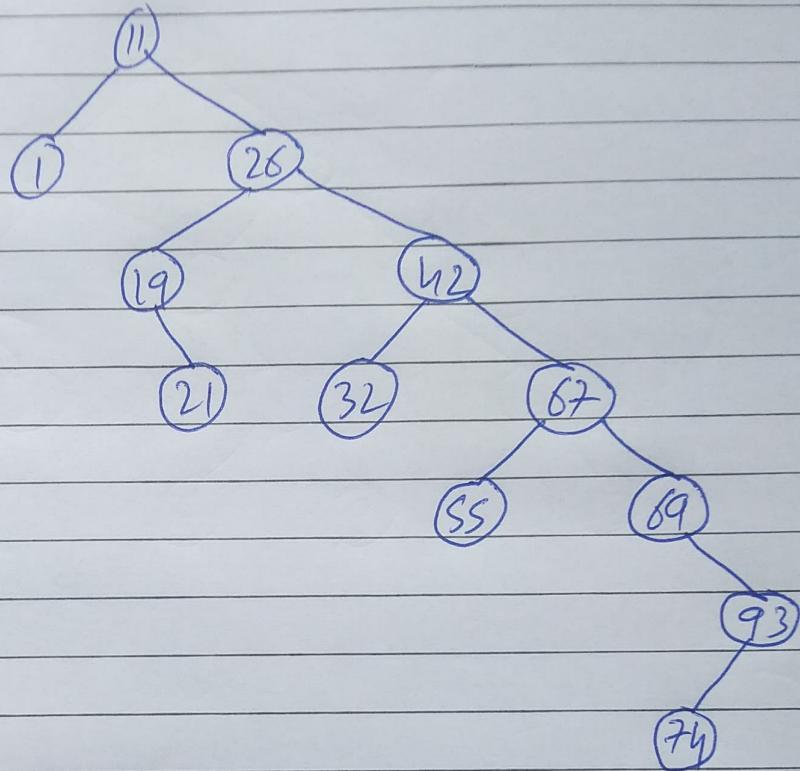
→ splay at 5



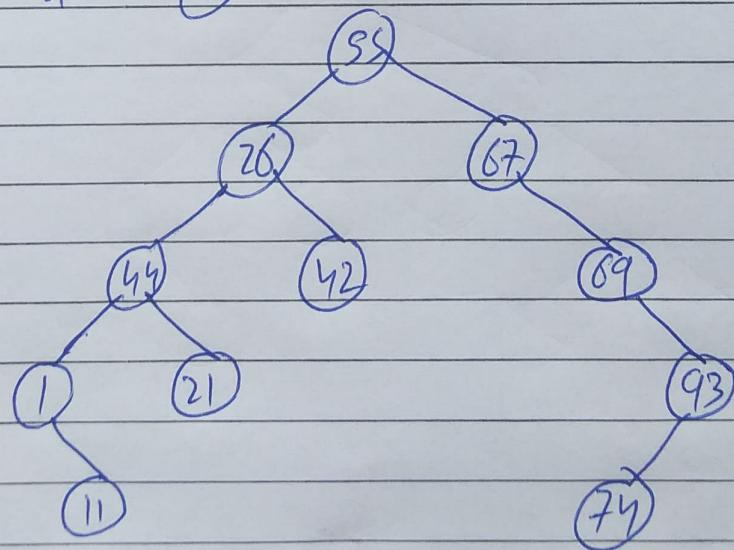
\* splay at 11, 55, 74



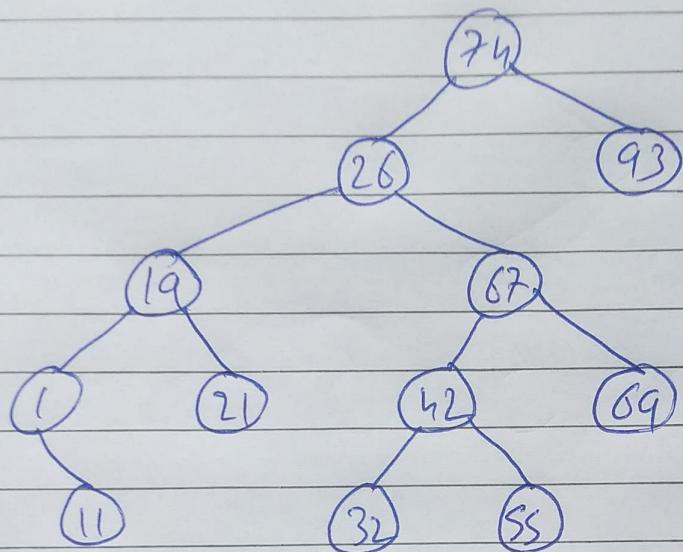
→ splay at 11



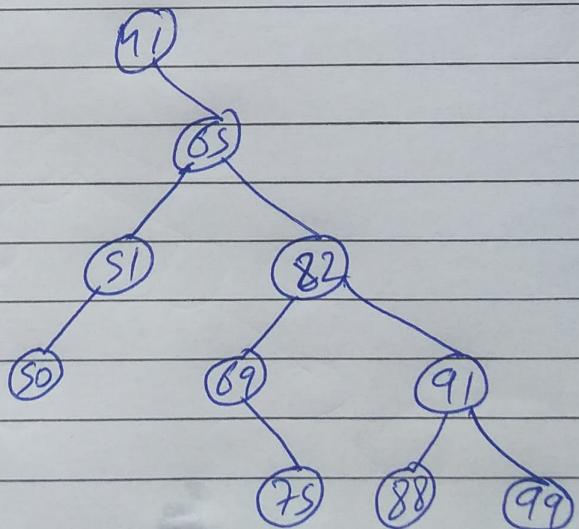
→ splay at 35



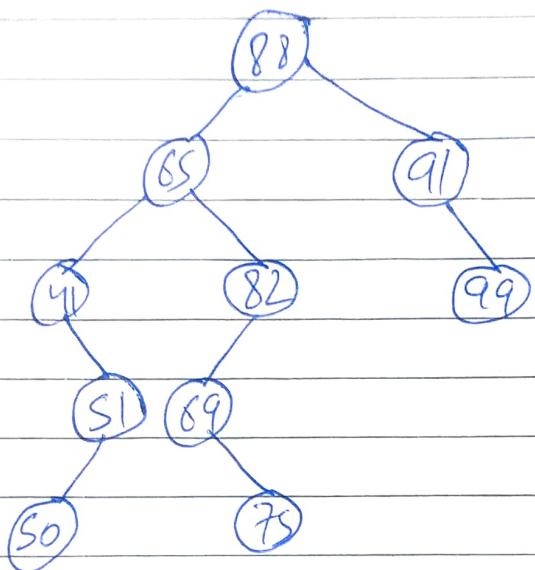
-> splay at 74



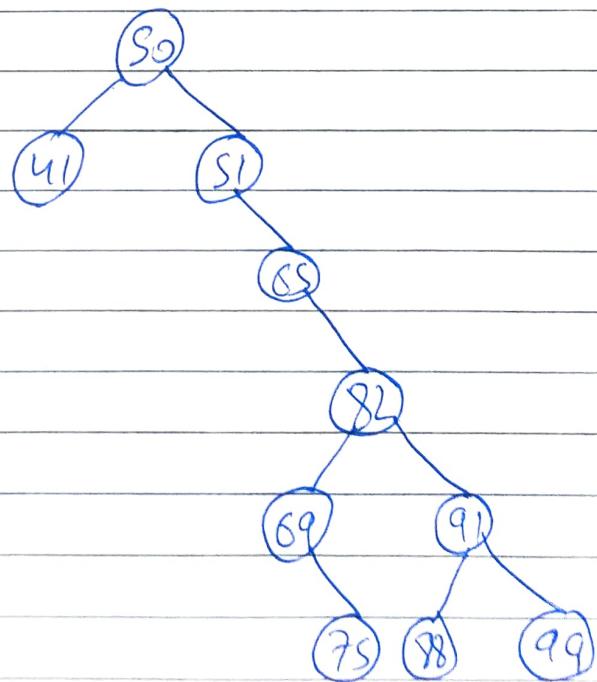
\* Splay at 88, 50



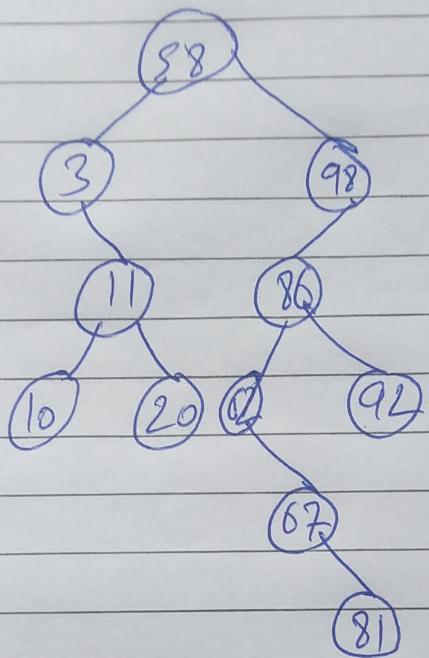
→ splay at (88)



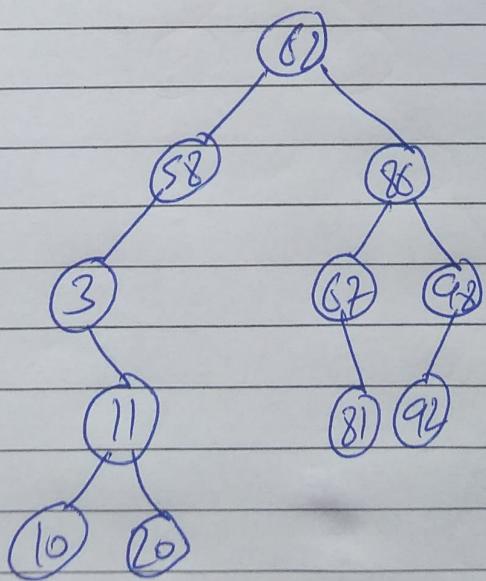
→ splay at (50)



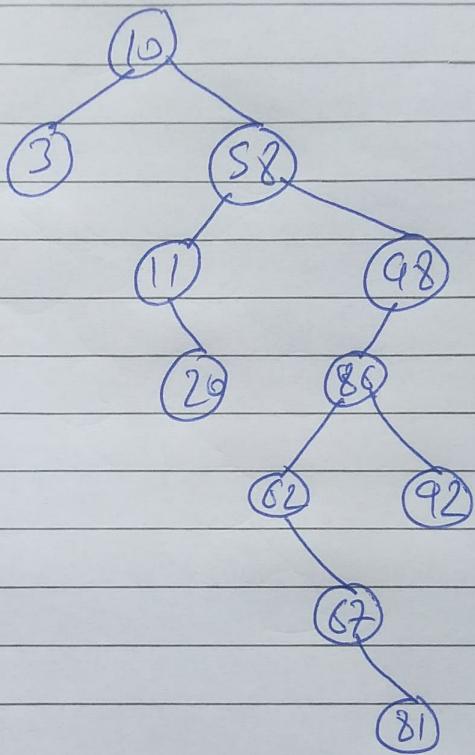
→ splay at 62, 10



→ splay at 62



→ splay at 16



B-Tree, B+ tree & B\* tree.

- Q. Create B-tree of order 3, 4, and 5 from the following data. Also create B+ tree and B\* tree of order 4.

6, 9S, 47, 32, 28, 87, 35, 51, 16, 39, 89, 97, 99.

B tree of order 3.

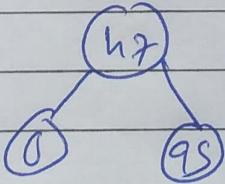
→ Insert 6

(6)

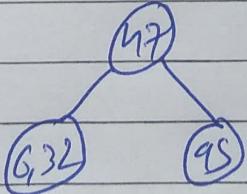
→ Insert 9S

(6, 9S)

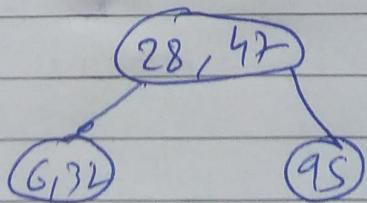
→ Insert 47



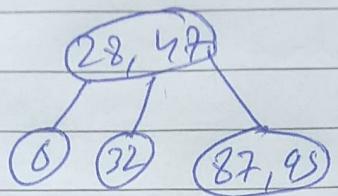
→ Insert 32



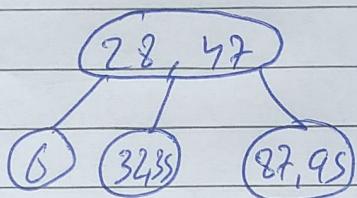
→ Insert 28



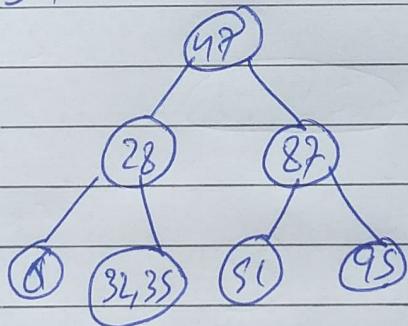
→ Insert 87



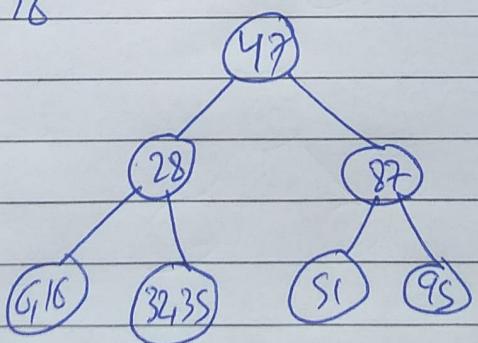
→ Insert 35



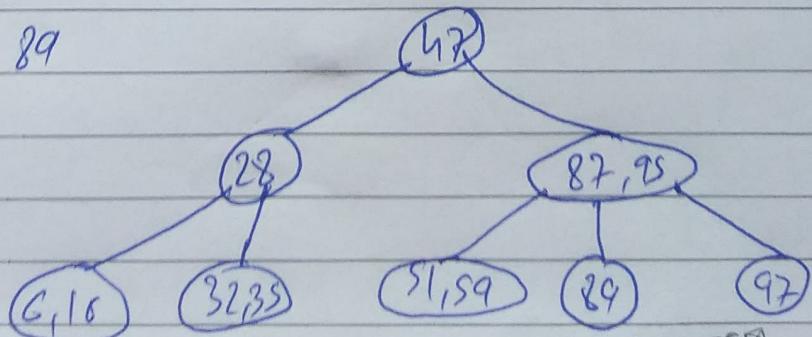
→ Insert 51



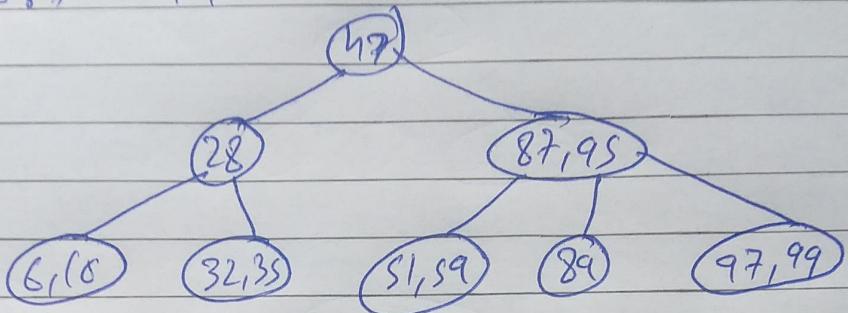
→ Insert 16



→ Insert 89



→ Insert 99

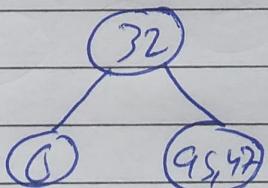


B-tree of order 4

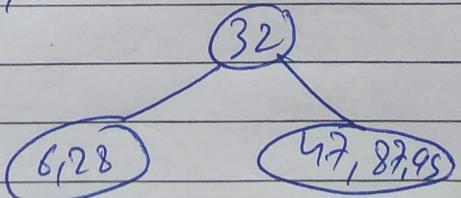
→ Insert 6, 95, 47

6,95, 47

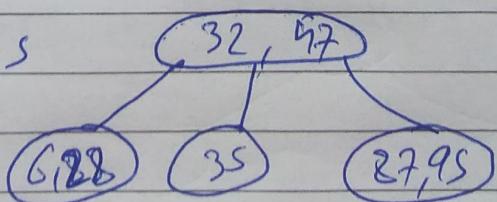
→ Insert 32



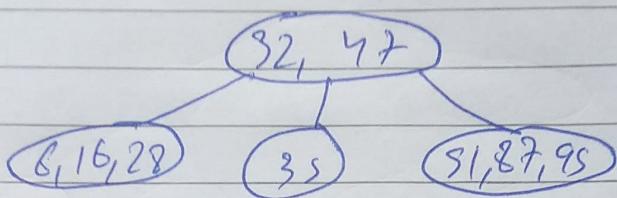
→ Insert 28, 87



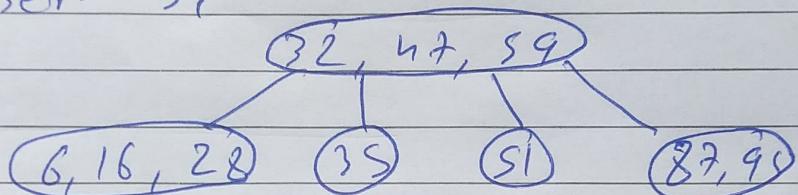
→ Insert 35



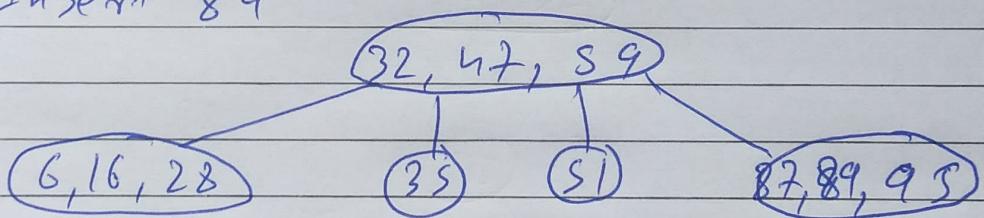
→ Insert 51, 16



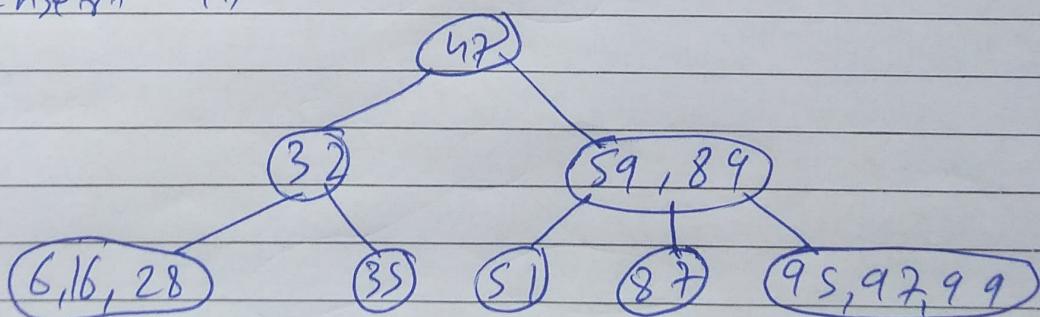
→ Insert 59



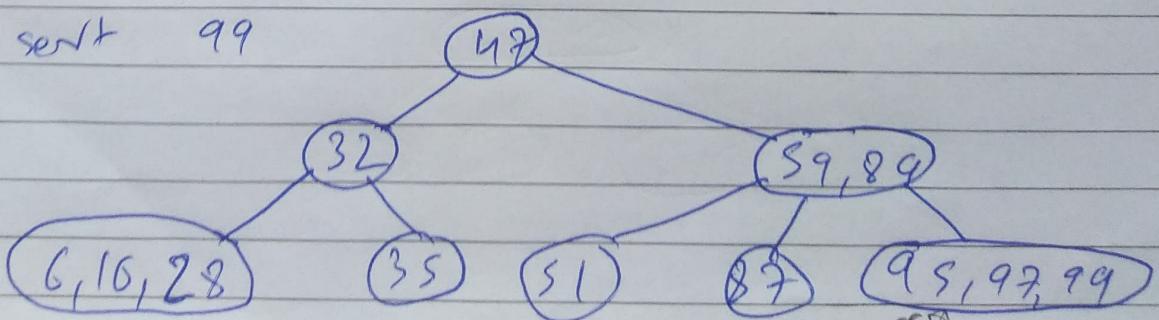
→ Insert 89



→ Insert 97



→ Insert 99

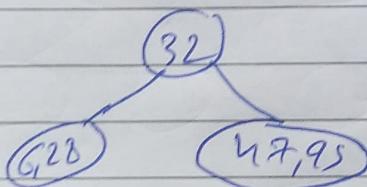


\* B-tree of order 3

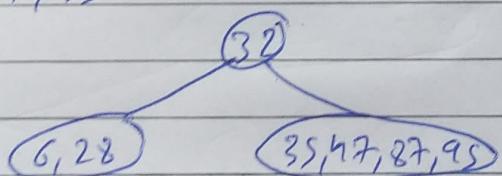
→ Insert 6, 95, 47, 32

(6, 32, 47, 95)

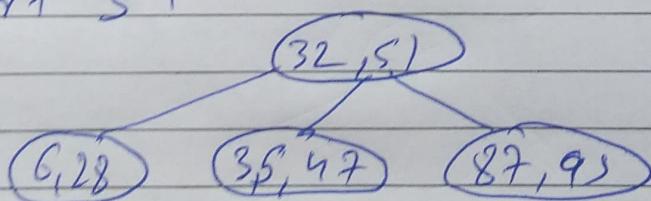
→ Insert 28



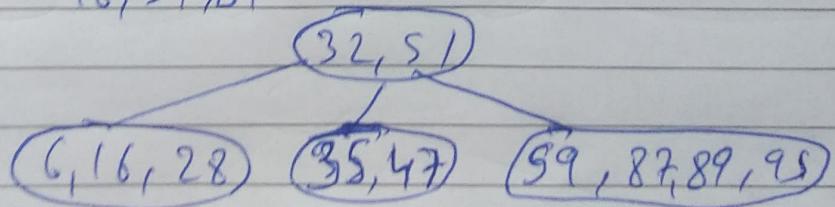
→ Insert 87, 35



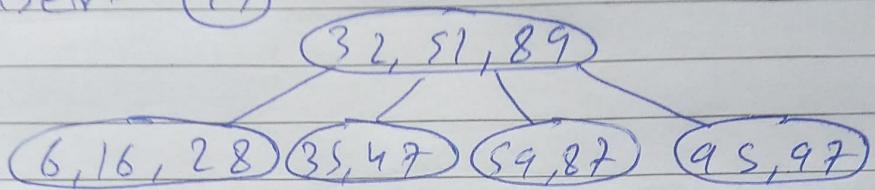
→ Insert 51



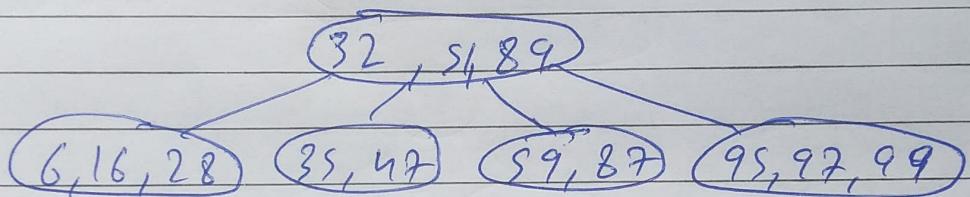
→ Insert 16, 59, 89



→ Insert 97

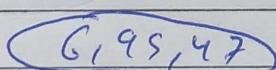


→ Insert 99

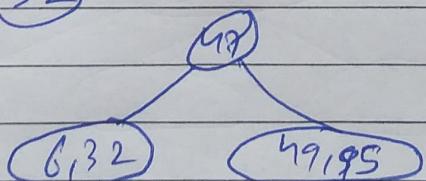


\* B + tree of order 4

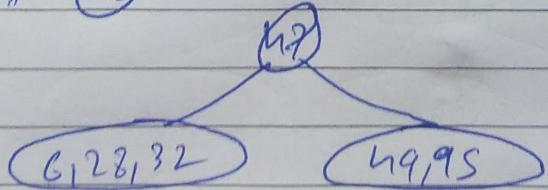
→ Insert 6, 95, 47



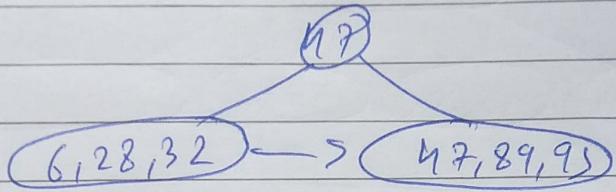
→ Insert 32



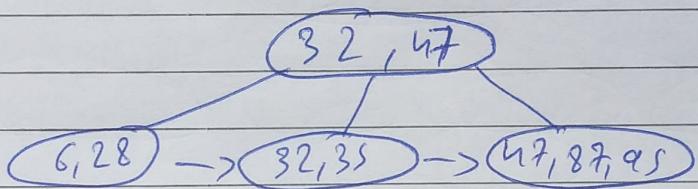
→ Insert 28



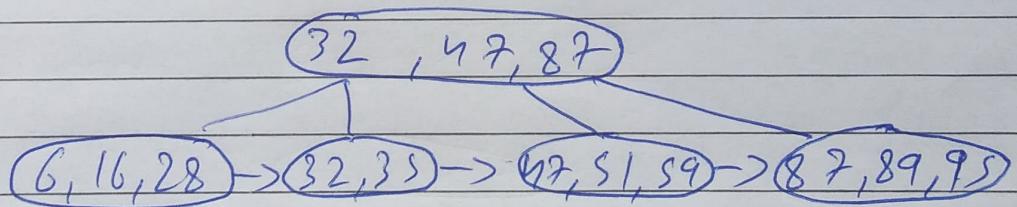
→ Insert 87



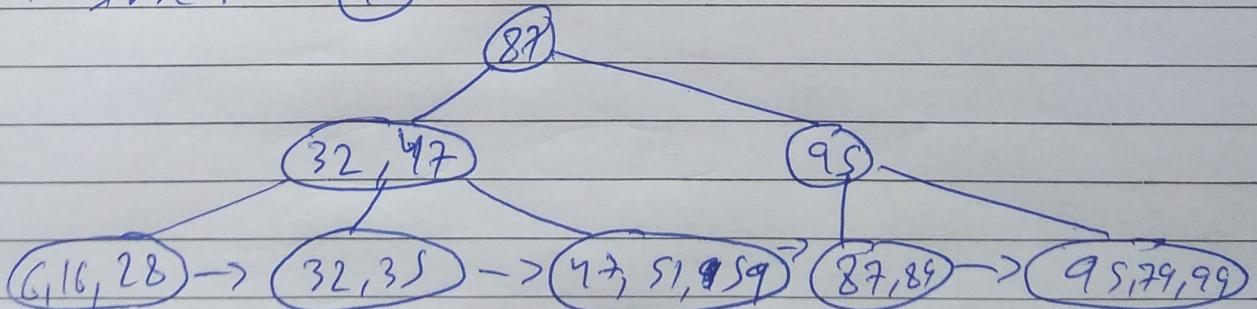
→ Insert 35



→ Insert 51, 16, 89

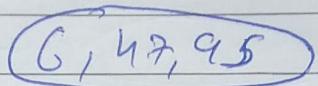


→ Insert 92

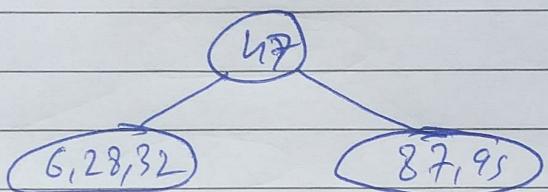


\* B\* tree of order 4

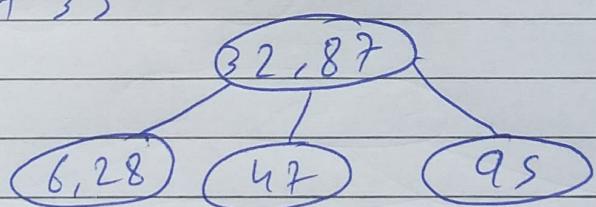
→ Insert 6, 95, 47



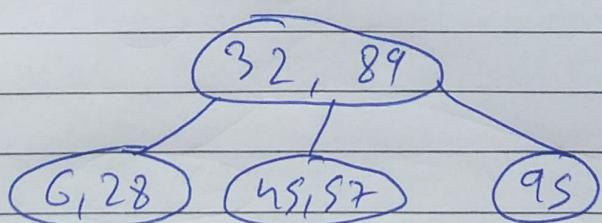
→ Insert 32, 28, 87



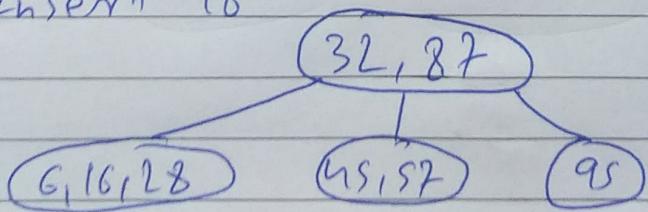
→ Insert 31



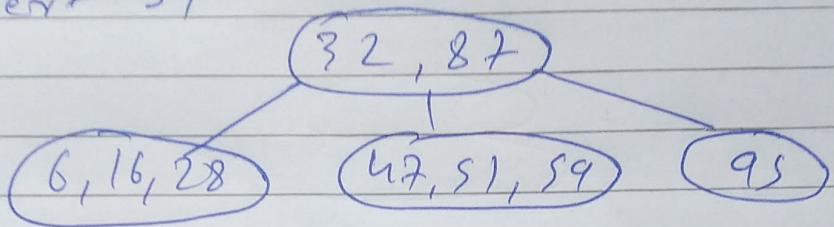
→ Insert 51



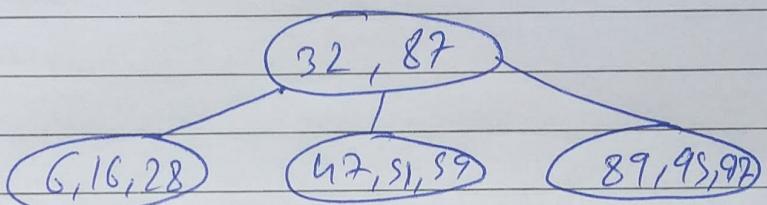
→ Insert 16



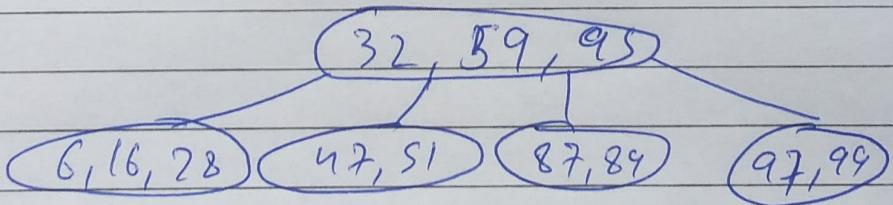
→ Insert 59



→ Insert 89, 97



→ Insert 99



## Polynomial Addition with Array

```
#include <iostream>
using namespace std;

// max function
int max(int m, int n)
{
    return (m > n)? m: n;
}

// addition function
int *add(int A[], int B[], int m, int n)
{
    int size = max(m, n);
    int *sum = new int[size];

    for (int i = 0; i<m; i++)
        sum[i] = A[i];

    for (int i=0; i<n; i++)
        sum[i] += B[i];

    return sum;
}

// print function
void print(int poly[], int n)
{
    for (int i=0; i<n; i++)
    {
        cout << poly[i];
        if (i != 0)
            cout << "x^" << i ;
        if (i != n-1)
            cout << " + ";
    }
}

// main function
int main()
{
    int A[] = {10, 20, 30};
    int B[] = {40, 30, 20, 10};
    int m = sizeof(A)/sizeof(A[0]);
    int n = sizeof(B)/sizeof(B[0]);
```

```
cout << "First polynomial is \n";
print(A, m);
cout << "\nSecond polynomial is \n";
print(B, n);

int *sum = add(A, B, m, n);
int size = max(m, n);

cout << "\nsum polynomial is \n";
print(sum, size);

return 0;
}
```

### **Output :**

First polynomial is

$10 + 20x^1 + 30x^2$

Second polynomial is

$40 + 30x^1 + 20x^2 + 10x^3$

sum polynomial is

$50 + 50x^1 + 50x^2 + 10x^3$

## Polynomial Multiplication with Array

```
#include <iostream>
using namespace std;

int *multiply(int A[], int B[], int m, int n)
{
    int *prod = new int[m+n-1];

    for (int i = 0; i<m+n-1; i++)
        prod[i] = 0;

    for (int i=0; i<m; i++)
    {
        for (int j=0; j<n; j++)
        {
            prod[i+j] += A[i]*B[j];
        }
    }
    return prod;
}

void print(int poly[], int n)
{
    for (int i=0; i<n; i++)
    {
        cout << poly[i];
        if (i != 0)
        {
            cout << "x^" << i ;
        }

        if (i != n-1)
        {
            cout << " + ";
        }
    }
}

//main function
int main()
{
    int A[] = {10, 20, 30};
    int B[] = {40, 30, 20, 10};
    int m = sizeof(A)/sizeof(A[0]);
    int n = sizeof(B)/sizeof(B[0]);
```

```
cout << "First polynomial is n";
print(A, m);
cout << "nSecond polynomial is n";
print(B, n);

int *prod = multiply(A, B, m, n);

cout << "nProduct polynomial is n";
print(prod, m+n-1);

return 0;
}
```

**Output :**

**First polynomial is**

**$10 + 20x^1 + 30x^2$**

**Second polynomial is**

**$40 + 30x^1 + 20x^2 + 10x^3$**

**Product polynomial is**

**$400 + 1100x^1 + 2000x^2 + 1400x^3 + 800x^4 + 300x^5$**

## Polynomial Addition with LL

```
#include<iostream>
using namespace std;

struct Node
{
    int coefficient;
    int pow;
    struct Node *next;
};

void create_node(int x, int y, struct Node **temp)
{
    struct Node *r, *z;
    z = *temp;
    if(z == NULL)
    {
        r =(struct Node*)malloc(sizeof(struct Node));
        r->coefficient = x;
        r->pow = y;
        *temp = r;
        r->next = (struct Node*)malloc(sizeof(struct Node));
        r = r->next;
        r->next = NULL;
    }
    else
    {
        r->coefficient = x;
        r->pow = y;
        r->next = (struct Node*)malloc(sizeof(struct Node));
        r = r->next;
        r->next = NULL;
    }
}

void polyadd(struct Node *poly1, struct Node *poly2, struct Node *poly)
{
while(poly1->next && poly2->next)
{
    if(poly1->pow > poly2->pow)
    {
        poly->pow = poly1->pow;
        poly->coefficient = poly1->coefficient;
        poly1 = poly1->next;
    }
}
```

```

        else if(poly1->pow < poly2->pow)
        {
            poly->pow = poly2->pow;
            poly->coefficient = poly2->coefficient;
            poly2 = poly2->next;
        }
        else
        {
            poly->pow = poly1->pow;
            poly->coefficient = poly1->coefficient+poly2->coefficient;
            poly1 = poly1->next;
            poly2 = poly2->next;
        }

        poly->next = (struct Node *)malloc(sizeof(struct Node));
        poly = poly->next;
        poly->next = NULL;
    }
while(poly1->next || poly2->next)
{
    if(poly1->next)
    {
        poly->pow = poly1->pow;
        poly->coefficient = poly1->coefficient;
        poly1 = poly1->next;
    }
    if(poly2->next)
    {
        poly->pow = poly2->pow;
        poly->coefficient = poly2->coefficient;
        poly2 = poly2->next;
    }
    poly->next = (struct Node *)malloc(sizeof(struct Node));
    poly = poly->next;
    poly->next = NULL;
}
}

void show(struct Node *node)
{
while(node->next != NULL)
{
    printf("%dx^%d", node->coefficient, node->pow);
    node = node->next;
    if(node->next != NULL)
        printf(" + ");
}
}

```

```
}
```

```
int main()
{
    struct Node *poly1 = NULL, *poly2 = NULL, *poly = NULL;

    create_node(5,2,&poly1);
    create_node(4,1,&poly1);
    create_node(2,0,&poly1);
    create_node(5,1,&poly2);
    create_node(5,0,&poly2);

    printf("1st Number: ");
    show(poly1);

    printf("\n2nd Number: ");
    show(poly2);

    poly = (struct Node *)malloc(sizeof(struct Node));
    polyadd(poly1, poly2, poly);
    printf("\nAdded polynomial: ");
    show(poly);

    return 0;
}
```

### Output :

**1st Number:**  $5x^2 + 4x^1 + 2x^0$

**2nd Number:**  $5x^1 + 5x^0$

**Added polynomial:**  $5x^2 + 9x^1 + 7x^0$

## Polynomial Multiplication with LL

```
#include <iostream>
using namespace std;

struct Node {
    int coefficient, power;
    Node* next;
};

Node* addnode(Node* start, int coeff, int power)
{
    Node* newnode = new Node;
    newnode->coefficient = coeff;
    newnode->power = power;
    newnode->next = NULL;

    if (start == NULL)
        return newnode;

    Node* ptr = start;
    while (ptr->next != NULL)
        ptr = ptr->next;
    ptr->next = newnode;

    return start;
}

void printList(struct Node* ptr)
{
    while (ptr->next != NULL) {
        cout << ptr->coefficient << "x^" << ptr->power << " + ";

        ptr = ptr->next;
    }
    cout << ptr->coefficient << "\n";
}

void removeDuplicates(Node* start)
{
    Node *ptr1, *ptr2, *dup;
    ptr1 = start;

    while (ptr1 != NULL && ptr1->next != NULL) {
        ptr2 = ptr1;
        while (ptr2->next != NULL) {
```

```

        if (ptr1->power == ptr2->next->power) {
            ptr1->coefficient = ptr1->coefficient + ptr2->next-
>coefficient;
            dup = ptr2->next;
            ptr2->next = ptr2->next->next;
            delete (dup);
        }
        else
            ptr2 = ptr2->next;
    }
    ptr1 = ptr1->next;
}
}

Node* multiply(Node* poly1, Node* poly2,
               Node* poly3)
{
    Node *ptr1, *ptr2;
    ptr1 = poly1;
    ptr2 = poly2;
    while (ptr1 != NULL) {
        while (ptr2 != NULL) {
            int coeff, power;
            coeff = ptr1->coefficient * ptr2->coefficient;
            power = ptr1->power + ptr2->power;
            poly3 = addnode(poly3, coeff, power);
            ptr2 = ptr2->next;
        }
        ptr2 = poly2;
        ptr1 = ptr1->next;
    }
    removeDuplicates(poly3);
    return poly3;
}

// Driver Code
int main()
{
    Node *poly1 = NULL, *poly2 = NULL, *poly3 = NULL;
    poly1 = addnode(poly1, 3, 2);
    poly1 = addnode(poly1, 5, 1);
    poly1 = addnode(poly1, 6, 0);
    poly2 = addnode(poly2, 6, 1);
    poly2 = addnode(poly2, 8, 0);

    cout << "1st Polynomial:- ";
}

```

```
printList(poly1);

cout << "2nd Polynomial:- ";
printList(poly2);

poly3 = multiply(poly1, poly2, poly3);

cout << "Resultant Polynomial:- ";
printList(poly3);

return 0;
}
```

**Output :**

**1st Polynomial:-  $3x^2 + 5x^1 + 6$**

**2nd Polynomial:-  $6x^1 + 8$**

**Resultant Polynomial:-  $18x^3 + 54x^2 + 76x^1 + 48$**

## Singly LinkList

```
#include<iostream>
using namespace std;

// Structure Declaration
struct node{
    int data;
    struct node *next;
};

// Functions Declaration
void menu(struct node *,struct node *);
int get_n(char);
struct node * insert_beg(struct node *,struct node *,int);
struct node * insert_end(struct node *,struct node *, int);
struct node * insert_atany(struct node *,struct node *, int);
struct node * delete_data(struct node *,struct node *, int);
void display_link(struct node *);

// Void Main
int main()
{
    struct node *struct_new;
    struct node *head = NULL;
    menu(struct_new,head); // Calling menu funtion
    return 0;
}

// menu function
void menu( struct node *struct_new, struct node *head )
{
    int n,getnum;
    cout << "\n 1 . Add New Data To Linklist From Begining. \n 2 . Add New Data To Linklist From Ending.\n 3 . Add New Data To Linklist At Any Place. \n 4 . Delete a Number From The LinkList. \n 5 . Display LinkList Till Now. \n 6 . Exit. \n";
    cin >> n;
    // Switch case which check the user input and run specified function
    switch(n)
    {
        case(1):
            getnum = get_n('i');
            head = insert_beg(struct_new,head,getnum);    //insertion from beginning linklist function call
            menu(struct_new,head);      //void menu function call
        case(2):
```

```

        getnum = get_n('i');
        head = insert_end(struct_new,head,getnum);    //insertion from endi
ng linklist function call
        menu(struct_new,head);      //void menu function call
    case(3):
        getnum = get_n('i');
        head = insert_atany(struct_new,head,getnum);   //insertion from an
y point linklist function call
        menu(struct_new,head);      //void menu function call
    case(4):
        getnum = get_n('d');
        head = delete_data(struct_new,head,getnum);
        menu(struct_new,head);
    case(5):
        display_link(head);      //display linklist function call
        menu(struct_new,head);      //void menu function call
    case(6):
        exit(0);      //exit function call which terminated the program
    default:
        cout << "\n Please Enter Valid Number.";
        menu(struct_new,head);      //void menu function call
    }
}

// function for taking input from user

int get_n(char a)
{
    int n;
    if( a == 'i' )
    {
        cout << " Enter The Number : ";
    }
    else{
        cout << " Enter The Number to Delete : ";
    }
    scanf("%d",&n);
    return n;
}

// function insert_beg, use for linklist begining insertion
struct node * insert_beg( struct node *struct_new, struct node *head,int n )
{
    struct_new = (struct node *)malloc(sizeof(struct node));
    struct_new->data = n;
    struct_new->next = head;
    head = struct_new;
    return head;
}

```

```

}

// function insert_end, use for linklist ending insertion
struct node * insert_end( struct node *struct_new, struct node *head, int n )
{
    struct node *temp;
    struct_new = (struct node *)malloc(sizeof(struct node));
    if( head == NULL )
    {
        head = struct_new;
        temp = head;
    }
    else{
        temp = head;
        while( temp->next != NULL ) // loop until next has NULL
        {
            temp = temp->next;
        }
    }
    temp->next = struct_new;
    struct_new->data = n;
    struct_new->next = NULL;
    return head;
}

// function insert_atany, use for linklist any-point insertion
struct node * insert_atany( struct node *struct_new, struct node *head, int n )
{
    struct node *first;
    struct node *last;
    first = head;
    struct_new = (struct node *)malloc(sizeof(struct node));
    if( head == NULL || head->data >= n ) // check if head already NULL or input value of user need to insert at begining
    {
        struct_new->data = n;
        struct_new->next = head;
        head = struct_new;
    }
    else{
        while( first != NULL && first->data < n ) // loop until user input in greater
        {
            last = first; // store last linklist address
            first = first->next; // store next linklist address
        }
    }
}

```

```

        struct_new->data = n;
        struct_new->next = first;
        last->next = struct_new;
    }
    return head;
}

struct node * delete_data( struct node *struct_new, struct node *head,int n )
{
    struct node *temp,*tempstore;
    temp = head;
    if( head == NULL )
    {
        cout << "\n There is Nothing To Delete. \n";
    }
    else if( temp->data == n )
    {
        head = temp->next;
        free(temp);
    }
    else{
        if( temp->data != n && temp->next == NULL )
        {
            cout << "\n No Such Data To Delete. \n";
        }
        else if( temp->data == n && temp->next == NULL )
        {
            free(temp);
            head = NULL;
        }
        else{
            while( temp->next->data != n )
            {
                if( temp->next->next != NULL )
                {
                    temp = temp->next;
                }
                else{
                    cout << "\n No Such Data To Delete. \n";
                    menu(struct_new,head);
                }
            }
            tempstore = temp->next;
            temp->next = temp->next->next;
            free(tempstore);
        }
    }
    return head;
}

```

```

}

// function display_link will display the linklist elements
void display_link(struct node *head)
{
    struct node *temp;
    if(head == NULL)    // check wheater the head is null
    {
        cout << "\nThere Is Nothing To Display.\n";
    }
    else
    {
        temp = head;
        cout << "\nThe List is : \n";
        while(temp->next != NULL)    // print all the elements from the link-
list
        {
            cout << temp->data << " => ";
            temp = temp->next;
        }
        cout << temp->data;
    }
}

```

### **Output :**

- 1 . Add New Data To Linklist From Begining.**
- 2 . Add New Data To Linklist From Ending.**
- 3 . Add New Data To Linklist At Any Place.**
- 4 . Delete a Number From The Link-List.**
- 5 . Display LinkList Till Now.**
- 6 . Exit.**

**1**

**Enter The Number : 3**

- 1 . Add New Data To Linklist From Begining.**
- 2 . Add New Data To Linklist From Ending.**

**3 . Add New Data To Linklist At Any Place.**

**4 . Delete a Number From The Link-List.**

**5 . Display LinkList Till Now.**

**6 . Exit.**

**1**

**Enter The Number : 2**

**1 . Add New Data To Linklist From Begining.**

**2 . Add New Data To Linklist From Ending.**

**3 . Add New Data To Linklist At Any Place.**

**4 . Delete a Number From The Link-List.**

**5 . Display LinkList Till Now.**

**6 . Exit.**

**2**

**Enter The Number : 6**

**1 . Add New Data To Linklist From Begining.**

**2 . Add New Data To Linklist From Ending.**

**3 . Add New Data To Linklist At Any Place.**

**4 . Delete a Number From The Link-List.**

**5 . Display LinkList Till Now.**

**6 . Exit.**

**3**

**Enter The Number : 5**

**1 . Add New Data To Linklist From Begining.**

**2 . Add New Data To Linklist From Ending.**

**3 . Add New Data To Linklist At Any Place.**

**4 . Delete a Number From The Link-List.**

**5 . Display LinkList Till Now.**

**6 . Exit.**

**5**

**The List is :**

**2 => 3 => 5 => 6 %d**

**1 . Add New Data To Linklist From Begining.**

**2 . Add New Data To Linklist From Ending.**

**3 . Add New Data To Linklist At Any Place.**

**4 . Delete a Number From The Link-List.**

**5 . Display LinkList Till Now.**

**6 . Exit.**

**4**

**Enter The Number to Delete : 5**

**1 . Add New Data To Linklist From Begining.**

**2 . Add New Data To Linklist From Ending.**

**3 . Add New Data To Linklist At Any Place.**

**4 . Delete a Number From The Link-List.**

**5 . Display LinkList Till Now.**

**6 . Exit.**

**5**

**The List is :**

**2 => 3 => 6**

- 1 . Add New Data To Linklist From Begining.**
- 2 . Add New Data To Linklist From Ending.**
- 3 . Add New Data To Linklist At Any Place.**
- 4 . Delete a Number From The Link-List.**
- 5 . Display LinkList Till Now.**
- 6 . Exit.**

## Stack With Array

```
#include <iostream>
using namespace std;
template <typename T>

class Stack
{
    T *data;
    short top, size;

public:
    Stack(int size)
    {
        if (size < 1)
            size = 5;
        this->size = size;
        top = -1;
        data = new T[this->size];
    }

    bool isFull()
    {
        return (top > size - 1);
    }

    bool isEmpty()
    {
        return (top < 0);
    }

    void push(T item)
    {
        if (isFull())
        {
            cout << "Stack Overflow" << endl;
            return;
        }
        data[++top] = item;
    }

    T pop()
    {
        if (isEmpty())
        {
            cout << "Stack is empty!" << endl;
            return NULL;
        }
        return data[top--];
    }
}
```

```
}

void display()
{
    if (isEmpty())
        cout << "Stack is empty!" << endl;
    else
    {
        cout << "TOP -> " << endl;
        for (int i = top; i >= 0; i--)
            cout << "-> " << data[i] << endl;
    }
}

~Stack()
{
    if (data)
        delete data;
}

void menu();
int main()
{
    menu();
    return 0;
}
void menu()
{
    short size;
    cout << "Enter the size of stack: ";
    cin >> size;
    Stack<int> stack1(size);
    short check;
    int item;
    do
    {
        cout << "\n1. Push\n2. Pop\n3. Display\n4. Exit\n-> ";
        cin >> check;
        switch (check)
        {
            case 1:
                cout << "Enter item to push: ";
                cin >> item;
                stack1.push(item);
                break;
            case 2:
                item = stack1.pop();
                if (item)
```

```
        cout << "Deleted Item: " << item << endl;
    break;
case 3:
    stack1.display();
break;
case 4:
break;
default:
    cout << "Select Proper Selection." << endl;
}
} while (check);
}
```

**Output :**

**Enter the size of stack: 4**

**1. Push**

**2. Pop**

**3. Display**

**4. Exit**

-> 1

**Enter item to push: 5**

**1. Push**

**2. Pop**

**3. Display**

**4. Exit**

-> 1

**Enter item to push: 3**

**1. Push**

**2. Pop**

**3. Display**

**4. Exit**

-> 3

**TOP ->**

-> 3

-> 5

**1. Push**

**2. Pop**

**3. Display**

**4. Exit**

-> 2

**Deleted Item: 3**

**1. Push**

**2. Pop**

**3. Display**

**4. Exit**

-> 3

**TOP ->**

-> 5

**1. Push**

**2. Pop**

**3. Display**

**4. Exit**

-> 4

## Stack With LL

```
#include <iostream>
using namespace std;
class Stack
{
    class Item
    {
        public:
            int data;
            Item *nextItem;

            Item(int value)
            {
                data = value;
                nextItem = NULL;
            }

            ~Item()
            {
                if (nextItem)
                    delete nextItem;
            }
    };
    Item *top;
    short numberOfItems, size;
public:
    Stack(int size)
    {
        if (size < 1)
            size = 5;
        this->size = size;
        numberOfItems = 0;
        top = NULL;
    }

    bool isFull()
    {
        return (numberOfItems >= size);
    }

    bool isEmpty()
    {
        return !top;
    }

    void push(int value)
```

```

{
    if (isFull())
    {
        cout << "Stack Overflow" << endl;
        return;
    }
    Item *item = new Item(value);
    item->nextItem = top;
    top = item;
    numberOfItems++;
}

int pop()
{
    if (isEmpty())
    {
        cout << "Stack is empty!" << endl;
        return NULL;
    }
    Item *itemToDelete = top;
    top = itemToDelete->nextItem;
    itemToDelete->nextItem = NULL;
    int deletedData = itemToDelete->data;
    numberOfItems--;
    delete itemToDelete;
    return deletedData;
}
void display()
{
    if (isEmpty())
        cout << "Stack is empty!" << endl;
    else
    {
        cout << "TOP -> ";
        Item *item = top;
        while (item)
        {
            cout << "-> " << item->data << endl;
            item = item->nextItem;
        }
    }
}

~Stack()
{
    if (top)
        delete top;
}

```

```
};

void menu();

int main()
{
    menu();
    return 0;
}
void menu()
{
    short size;
    cout << "Enter the size of stack: ";
    cin >> size;
    Stack stack1(size);
    short option;
    int item;

    do
    {
        cout << "\n-> 1. Push\n-> 2. Pop\n-> 3. Display\n-> 0. Exit\n-> ";
        cin >> option;
        switch (option)
        {
            case 1:
                cout << "Enter item to push: ";
                cin >> item;
                stack1.push(item);
                break;
            case 2:
                item = stack1.pop();
                if (item)
                    cout << "Deleted Item: " << item << endl;
                break;
            case 3:
                stack1.display();
                break;
            case 0:
                break;
            default:
                cout << "Wrong choice!" << endl;
        }
    } while (option);
}
```

**Output :**

**Enter the size of stack: 5**

-> 1. Push

-> 2. Pop

-> 3. Display

-> 0. Exit

-> 1

**Enter item to push: 6**

-> 1. Push

-> 2. Pop

-> 3. Display

-> 0. Exit

-> 2

**Deleted Item: 6**

-> 1. Push

-> 2. Pop

-> 3. Display

-> 0. Exit

-> 3

**Stack is empty!**

-> 1. Push

-> 2. Pop

-> 3. Display

-> 0. Exit

-> 1

Enter item to push: 8

-> 1. Push

-> 2. Pop

-> 3. Display

-> 0. Exit

-> 1

Enter item to push: 5

-> 1. Push

-> 2. Pop

-> 3. Display

-> 0. Exit

-> 1

Enter item to push: 2

-> 1. Push

-> 2. Pop

-> 3. Display

-> 0. Exit

-> 3

TOP -> -> 2

-> 5

-> 8

-> 1. Push

-> 2. Pop

-> 3. Display

-> 0. Exit

## Factorial using Recursion

```
#include <iostream>
using namespace std;

// Get User Input
int input()
{
    int n;
    cout << "Enter The Number";
    cin >> n;
    return n;
}

// factorial function return all the factorial value until the limit
int factorial(int n)
{
    if (n < 2)
    {
        return 1;
    }
    else
    {
        return n*factorial(n-1);
    }
}

int main() {
    int n = input();
    cout << "Factorial of " << n << " is " << factorial(n);
    return 0;
}
```

**Output :**

**Factorial of 7 is 5040**

## Fibonacci using Recursion

```
#include <iostream>
using namespace std;

int fibonacci(int num)
{
    if((num==1) || (num==0))
    {
        return(num);
    }
    else
    {
        return(fibonacci(num-1)+fibonacci(num-2));
    }
}
int main()
{
    int limit, i = 0;
    cout << "Enter the limit for Fibonacci : ";
    cin >> limit;
    cout << "\nFibonacci Series : ";
    while( i < limit ) {
        cout << " " << fibonacci(i);
        i++;
    }
    return 0;
}
```

**Output :**

**Enter the limit for Fibonacci : 6**

**Fibonacci Series : 0 1 1 2 3 5**

## Infix To Postfix

```
#include<iostream>
#include <stack>
using namespace std;

int prec(char c)
{
    if(c == '^')
        return 3;
    else if(c == '*' || c == '/')
        return 2;
    else if(c == '+' || c == '-')
        return 1;
    else
        return -1;
}

void infixToPostfix(string s)
{
    std::stack<char> st;
    st.push('N');
    int l = s.length();
    string ns;
    for(int i = 0; i < l; i++)
    {
        if((s[i] >= 'a' && s[i] <= 'z')||(s[i] >= 'A' && s[i] <= 'Z'))
            ns+=s[i];
        else if(s[i] == '(')
            st.push('(');
        else if(s[i] == ')')
        {
            while(st.top() != 'N' && st.top() != '(')
            {
                char c = st.top();
                st.pop();
                ns += c;
            }
            if(st.top() == '(')
            {
                char c = st.top();
                st.pop();
            }
        }
        else
        {
```

```

        while(st.top() != 'N' && prec(s[i]) <= prec(st.top()))
    {
        char c = st.top();
        st.pop();
        ns += c;
    }
    st.push(s[i]);
}

}

while(st.top() != 'N')
{
    char c = st.top();
    st.pop();
    ns += c;
}

cout << ns << endl;
}

int main()
{
    string exp = "x-y*(a+b+c+d)";
    infixToPostfix(exp);
    return 0;
}

```

**Output :**

**xyab+c+d+\*-**

## Postfix Evaluation

```
#include <iostream>
#include <string.h>

using namespace std;

struct Stack{
    int top;
    unsigned capacity;
    int* array;
};

struct Stack* createStack( unsigned capacity ){
    struct Stack* stack = (struct Stack*) malloc(sizeof(struct Stack));

    if(!stack){
        return NULL;
    }

    stack->top = -1;
    stack->capacity = capacity;
    stack->array = (int*) malloc(stack->capacity * sizeof(int));

    if(!stack->array){
        return NULL;
    }

    return stack;
}

int isEmpty(struct Stack* stack){
    return stack->top == -1 ;
}

char peek(struct Stack* stack){
    return stack->array[stack->top];
}

char pop(struct Stack* stack){
    if(!isEmpty(stack)){
        return stack->array[stack->top--];
    }
    return '$';
}

void push(struct Stack* stack, char op){
```

```

    stack->array[++stack->top] = op;
}

int evaluatePostfix(char* exp){

    struct Stack* stack = createStack(strlen(exp));
    int i;

    if(!stack){
        return -1;
    }

    for(i = 0; exp[i]; ++i){
        if(isdigit(exp[i])){
            push(stack, exp[i] - '0');
        }
        else{
            int val1 = pop(stack);
            int val2 = pop(stack);
            switch(exp[i]){
                case '+': push(stack, val2 + val1); break;
                case '-': push(stack, val2 - val1); break;
                case '*': push(stack, val2 * val1); break;
                case '/': push(stack, val2/val1); break;
            }
        }
    }
    return pop(stack);
}

int main(){

    char s[] = "1234+5+6+7+*-";
    cout<<evaluatePostfix(s);

    return 0;
}

```

**Output :**

**-49**

## Queue with Array

```
#include <iostream>
using namespace std;

struct Queue {
    int front, rear, capacity;
    int* queue;
    Queue(int c)
    {
        front = rear = 0;
        capacity = c;
        queue = new int;
    }

    ~Queue() { delete[] queue; }

    void queueEnqueue(int data)
    {

        if (capacity == rear) {
            printf("\nQueue is full\n");
            return;
        }

        else {
            queue[rear] = data;
            rear++;
        }
        return;
    }

    void queueDequeue()
    {
```

```
if (front == rear) {
    printf("\nQueue is empty\n");
    return;
}

else {
    for (int i = 0; i < rear - 1; i++) {
        queue[i] = queue[i + 1];
    }

    rear--;
}
return;
}

void queueDisplay()
{
    int i;
    if (front == rear) {
        printf("\nQueue is Empty\n");
        return;
    }

    for (i = front; i < rear; i++) {
        printf(" %d <- ", queue[i]);
    }
    return;
}

void queueFront()
{
    if (front == rear) {
```

```
        printf("\nQueue is Empty\n");
        return;
    }
    printf("\nFront Element is: %d", queue[front]);
    return;
}

int main(void)
{
    Queue q(4);

    q.queueDisplay();

    q.queueEnqueue(20);
    q.queueEnqueue(30);
    q.queueEnqueue(40);
    q.queueEnqueue(50);

    q.queueDisplay();

    q.queueEnqueue(60);

    q.queueDisplay();

    q.queueDequeue();
    q.queueDequeue();

    printf("\n\nafter two node deletion\n\n");

    q.queueDisplay();
```

```
    q.queueFront();  
  
    return 0;  
}
```

**Output:**

Queue is Empty

20 <-- 30 <-- 40 <-- 50 <--

Queue is full

20 <-- 30 <-- 40 <-- 50 <--

after two node deletion

40 <-- 50 <--

Front Element is: 40

## Queue with Linked List

```
#include <iostream>
using namespace std;

struct QNode {
    int data;
    QNode* next;
    QNode(int d)
    {
        data = d;
        next = NULL;
    }
};

struct Queue {
    QNode *front, *rear;
    Queue()
    {
        front = rear = NULL;
    }

    void enqueue(int x)
    {

        QNode* temp = new QNode(x);

        if (rear == NULL) {
            front = rear = temp;
            return;
        }

        rear->next = temp;
        rear = temp;
    }
};
```

```
}

void deQueue()
{
    if (front == NULL)
        return;

    QNode* temp = front;
    front = front->next;

    if (front == NULL)
        rear = NULL;

    delete (temp);
}
};

int main()
{
    Queue q;
    q.enqueue(10);
    q.enqueue(20);
    q.dequeue();
    q.dequeue();
    q.enqueue(30);
    q.enqueue(40);
    q.enqueue(50);
    q.dequeue();
    cout << "Queue Front : " << (q.front)->data << endl;
    cout << "Queue Rear : " << (q.rear)->data;
}
```

**Output:**

Queue Front : 40

Queue Rear : 50

## Circular Queue with Array

```
#include <iostream>
#define SIZE 5

using namespace std;

class Queue {
    private:
        int items[SIZE], front, rear;

    public:
        Queue() {
            front = -1;
            rear = -1;
        }

        bool isFull() {
            if (front == 0 && rear == SIZE - 1) {
                return true;
            }
            if (front == rear + 1) {
                return true;
            }
            return false;
        }

        bool isEmpty() {
            if (front == -1)
                return true;
            else
                return false;
        }

        void enqueue(int element) {
            if (isFull())
                cout << "Queue is full";
            else
                items[rear] = element;
            if (front == -1)
                front = 0;
            rear = (rear + 1) % SIZE;
        }

        int dequeue() {
            if (isEmpty())
                cout << "Queue is empty";
            else
                int element = items[front];
                if (front == rear)
                    front = -1;
                else
                    front = (front + 1) % SIZE;
                return element;
        }
}
```

```
    } else {
        if (front == -1) front = 0;
        rear = (rear + 1) % SIZE;
        items[rear] = element;
        cout << endl
            << "Inserted " << element << endl;
    }
}

int deQueue() {
    int element;
    if (isEmpty()) {
        cout << "Queue is empty" << endl;
        return (-1);
    } else {
        element = items[front];
        if (front == rear) {
            front = -1;
            rear = -1;
        }

        else {
            front = (front + 1) % SIZE;
        }
        return (element);
    }
}

void display() {

    int i;
    if (isEmpty()) {
        cout << endl
            << "Empty Queue" << endl;
    } else {
        cout << "Front -> " << front;
        cout << endl
            << "Items -> ";
    }
}
```

```
        for (i = front; i != rear; i = (i + 1) % SIZE)
            cout << items[i];
        cout << items[i];
        cout << endl
            << "Rear -> " << rear;
    }
}
};

int main() {
Queue q;

q.deQueue();

q.enqueue(1);
q.enqueue(2);
q.enqueue(3);
q.enqueue(4);
q.enqueue(5);

q.enqueue(6);

q.display();

int elem = q.deQueue();

if (elem != -1)
    cout << endl
        << "Deleted Element is " << elem;

q.display();

q.enqueue(7);

q.display();
```

```
    q.enQueue(8);  
  
    return 0;  
}
```

**Output:**

Queue is empty

Inserted 1

Inserted 2

Inserted 3

Inserted 4

Inserted 5

Queue is fullFront -> 0

Items -> 12345

Rear -> 4

Deleted Element is 1Front -> 1

Items -> 2345

Rear -> 4

Inserted 7

Front -> 1

Items -> 23457

Rear -> 0Queue is full

## Circular Queue with Linked List

```
#include<iostream>

#define SIZE 100

using namespace std;

class node
{
public:
    node()
    {
        next = NULL;
    }
    int data;
    node *next;
}*front=NULL,*rear=NULL,*n,*temp,*temp1;

class cqueue
{
public:
    void insertion();
    void deletion();
    void display();
};

int main()
{
    cqueue cqobj;
    int ch;
    do
    {
        cout<<"\n\n\tMain Menu";
        cout<<"\n#####";
        cout<<"\n1. Insertion";
        cout<<"\n2. Deletion";
        cout<<"\n3. Display";
        cout<<"\n4. Exit";
        cout<<"\nEnter your choice: ";
        cin>>ch;
        switch(ch)
        {
            case 1:
                cout<<"\nEnter the data: ";
                cin>>n->data;
                n->next=rear;
                rear=n;
                break;
            case 2:
                if(front==NULL)
                    cout<<"\nQueue is empty";
                else
                    cout<<"\nDeletion successful";
                break;
            case 3:
                if(front==NULL)
                    cout<<"\nQueue is empty";
                else
                    cqobj.display();
                break;
            case 4:
                exit(0);
            default:
                cout<<"\nEnter a valid choice";
        }
    } while(ch!=4);
```

```

        cout<<"\n1. Insert\n2. Delete\n3. Display\n4. Exit\n\nEnter Your Choice: ";
        cin>>ch;
        switch(ch)
        {
            case 1:
                cqobj.insertion();
                cqobj.display();
                break;
            case 2:
                cqobj.deletion();
                break;
            case 3:
                cqobj.display();
                break;
            case 4:
                break;
            default:
                cout<<"\n\nWrong Choice!!! Try Again.";
        }
    }while(ch!=4);
    return 0;
}

void cqueue::insertion()
{
    n=new node[sizeof(node)];
    cout<<"\nEnter the Element: ";
    cin>>n->data;
    if(front==NULL)
    {
        front=n;
    }
    else
    {
        rear->next=n;
    }
    rear=n;
}

```

```
rear->next=front;
}

void cqueue::deletion()
{
    int x;
    temp=front;
    if(front==NULL)
    {
        cout<<"\nCircular Queue Empty!!!";
    }
    else
    {
        if(front==rear)
        {
            x=front->data;
            delete(temp);
            front=NULL;
            rear=NULL;
        }
        else
        {
            x=temp->data;
            front=front->next;
            rear->next=front;
            delete(temp);
        }
        cout<<"\nElement "<<x<<" is Deleted";
        display();
    }
}

void cqueue::display()
{
    temp=front;
    temp1=NULL;
    if(front==NULL)
    {
```

```
    cout<<"\n\nCircular Queue Empty!!!";
}
else
{
    cout<<"\n\nCircular Queue Elements are:\n\n";
    while(temp!=temp1)
    {
        cout<<temp->data<<"  ";
        temp=temp->next;
        temp1=front;
    }
}
}
```

**Output:**

Main Menu

#####

1. Insert
2. Delete
3. Display
4. Exit

Enter Your Choice: 1

Enter the Element: 25

Circular Queue Elements are:

Main Menu

#####

1. Insert
2. Delete
3. Display
4. Exit

Enter Your Choice: 1

Enter the Element: 70

Circular Queue Elements are:

25 70

Main Menu

#####

1. Insert
2. Delete
3. Display
4. Exit

Enter Your Choice: 2

Element 25 is Deleted

Circular Queue Elements are:

70

Main Menu

#####

1. Insert

2. Delete

3. Display

4. Exit

Enter Your Choice: 4

## Circular Linked List(All Insertions, All Deletions & Display)

```
#include <iostream>
using namespace std;

#define NULL 0

struct node
{
    int data ;
    struct node *next ;
} ;

struct node *first=NULL ;
struct node *last=NULL ;

void create()
{
    int i , n ;
    struct node *pnode , *p ;

    printf("Enter the number of nodes required:\n") ;
    scanf("%d",&n) ;

    printf("Enter the data value of each node:\n") ;
    for(i=1 ; i<=n ; i++)
    {
        pnode=(struct node*)malloc(sizeof(struct node)) ;
        if(pnode==NULL)
        {
            printf("Memory overflow. Unable to create.\n") ;
            return ;
        }

        scanf("%d",&pnode->data) ;

        if(first==NULL)
```

```
    first=last=pnode ;
else
{
    last->next=pnode ;
    last=pnode ; /* last keeps track of last node */
}

    last->next=first ;
}
}

void deletenode(int k)
{
    struct node *p , *follow ;

/* searching the required node */
p=first ;
follow=NULL ;
while(follow!=last)
{
    if(p->data==k)
        break ;
    follow=p ;
    p=p->next ;
}

if(follow==last)
    printf("Required node not found.\n") ;
else
{
    if(p==first&&p==last) /* deleting the one and the only
node */
        first=last=NULL ;
    else if(p==first) /* deleting the first node */
    {
        first=first->next ;
        last->next=first ;
    }
}
```

```

        else if(p==last)      /* deleting the last node */
    {
        last=follow ;
        last->next=first ;
    }
    else      /* deleting any other node */
        follow->next=p->next ;

        free(p) ;
    }
}

void traverse()
{
    struct node *p , *follow ;
    if(first==NULL)
        printf("Circularly Linked List Empty") ;
    else
    {
        printf("Circularly Linked List is as shown: \n") ;

        p=first ;
        follow = NULL ;
        while(follow!=last)
        {
            printf("%d " , p->data) ;
            follow=p ;
            p=p->next ;
        }

        printf("\n") ;
    }
}

int main()
{
    int x , k , ch ;

```

```
do
{
    printf("\n Menu: \n") ;
    printf("1>Create Linked List \n") ;
    printf("2>Delete Node \n") ;
    printf("3>Traverse \n") ;
    printf("4>Exit \n") ;

    printf("\nEnter your choice: ") ;
    scanf("%d",&ch) ;

    switch(ch)
    {
        case 1:
            create() ;
            break ;

        case 2:
            printf("Enter the data value of the node to be deleted
: ") ;
            scanf("%d",&k) ;
            deletenode(k) ;
            break ;

        case 3:
            traverse() ;
            break ;

        case 4:
            break ;
    }
}

while(ch!=4) ;

return 0;
}
```

**Output:**

Menu:

1>Create Linked List

2>Delete Node

3:Traverse

4:Exit

Enter your choice: 1

Enter the number of nodes required:

6

Enter the data value of each node:

34

2

67

12

99

77

Menu:

1>Create Linked List

2>Delete Node

3:Traverse

4:Exit

Enter your choice: 3

Circularly Linked List is as shown:

2 67 12 99 77

Menu:

- 1>Create Linked List
- 2>Delete Node
- 3>Traverse
- 4>Exit

Enter your choice: 2

Enter the data value of the node to be deleted: 34

Menu:

- 1>Create Linked List
- 2>Delete Node
- 3>Traverse
- 4>Exit

Enter your choice: 3

Circularly Linked List is as shown:

2 67 12 99 77

Menu:

- 1>Create Linked List
- 2>Delete Node
- 3>Traverse
- 4>Exit

Enter your choice: 2

Enter the data value of the node to be deleted: 99

Menu:

1>Create Linked List

2>Delete Node

3:Traverse

4:Exit

Enter your choice: 3

Circularly Linked List is as shown:

2 67 12 77

Menu:

1>Create Linked List

2>Delete Node

3:Traverse

4:Exit

Enter your choice: 4

## Doubly Link-list

```
#include<iostream>
#include<stdlib.h>
#include<new>

using namespace std;

class node{

public:

    int data;
    node *next;
    node *prev;
};

int getdata(){

    int value;
    cout<<"enter the value : ";
    cin>>value;
    return value;
}

void insert_atstart(node **head){

    int value = getdata();    //gets the value
    node *new_node=new node(); //allocates the memory to new node
    if(*head == NULL){
        new_node->next = NULL;
        new_node->prev = NULL;
        new_node->data = value;
        (*head)=new_node;
    }
    else{
        new_node->data = value;
        new_node->next = (*head);
        new_node->prev = NULL;
        (*head)->prev = new_node;
        (*head)=new_node;
    }
}

void insert_atend(node **head){}
```

```

int value = getdata();
node *new_node = new node();           //allocate memory to new node
node *last = *head;                   // stores the address reference of head
new_node->data = value;
new_node->next = NULL;
if(*head == NULL){
    new_node->prev = NULL;
    *head = new_node;
    return;
}
while(last->next != NULL)           //traverse to last node
    last = last->next;

last-
>next = new_node;      // change the next of last node to recently created node
new_node->prev = last;      //set last to prev of new node
return;

}

void insert_afterval(node **head){

    int value = getdata();
    int uservalue;

    cout<<"enter the aftervalue :";
    cin>>uservalue;
    node *new_node = new node();
    node *curr = NULL;
    node *temp = NULL;
    curr = *head;
    while(curr){
        if(curr->data == uservalue){
            break;
        }

        curr = curr->next;
    }
    new_node->data = value;
    temp = curr->next;
    curr->next = new_node;
    new_node->prev = curr;
    new_node->next = temp;

}

```

```

void delete_atstart(node **head)
{
    node *temp;
    if((*head) == NULL)
    {
        cout<<"UNDERFLOW";
    }
    else if((*head)->next == NULL)
    {
        (*head) = NULL;
        free(*head);
        cout<<"\n Node Deleted \n";
    }
    else
    {
        temp = *head;
        *head = (*head) -> next;
        (*head) -> prev = NULL;
        free(temp);
        cout<<" \n  Node Deleted\n";
    }
}
void delete_atend(node **head)
{
    node *temp = *head;
    if((*head) == NULL)
    {
        cout<<"UNDERFLOW";
    }
    else if(temp->next == NULL)
    {
        (*head) = NULL;
        temp = temp->next;
        cout<<"\n Node Deleted \n";
    }
    else
    {
        while(temp->next != NULL)
        {
            temp = temp -> next;
        }
        temp -> prev -> next = NULL;
        temp = temp->next;
        cout<<"\nNode Deleted\n";
    }
}

```

```

}

void delete_value(node **head)
{
    node *temp;
    int value;
    cout<<"Enter the value to be deleted : ";
    cin>>value;
    temp = *head;
    if(temp->data == value && temp->next == NULL){
        *head = NULL;
        free(temp);
        cout<<"list is empty";
    }
    else if(temp->data == value && temp->next != NULL){
        temp->next->prev = NULL;
        temp = temp->next;
    }
    else{

        while(temp->data != value && temp->next != NULL)
            temp = temp->next;

        if(temp == NULL){
            cout<<"value is not found";
        }
        else if(temp->next == NULL){
            temp->prev->next = NULL;
            temp = temp->next;
        }
        else{
            temp->prev->next = temp->next;
            temp->next->prev = temp->prev;
            temp = temp->next;
        }
    }
}
void display(node *head)
{
    int count_no=0;
    while(head != NULL){

        cout<<head->data<<" ";
        head=head->next;
        count_no++;
    }
}

```

```
    cout<<" \n no of nodes in the linked list are : " << count_no;
}
int main()
{
    node *head = NULL;
    int choice;
    cout<<" 1 for insert at beginning \n 2 for insert at end \n 3 for insert after
the given value \n 4 for delete from beginning";
    cout<<"\n 5 delete from end \n 6 delete the given value\n 7 display \n";
    cout<<"enter your choice : ";
    cin>>choice;
    while(choice!=0){

        if(choice == 1){
            insert_atstart(&head);
        }
        else if(choice == 2){
            insert_atend(&head);
        }
        else if(choice == 3){
            insert_afterval(&head);
        }
        else if(choice == 4){
            delete_atstart(&head);
        }
        else if(choice == 5){
            delete_atend(&head);
        }
        else if(choice == 6){
            delete_value(&head);
        }
        else if(choice == 7){
            display(head);
        }
        else{
            cout<<"incorrect choice";
            cout<<"enter your choice : ";
            cin>>choice;
        }
        cout<<"\n enter your choice : ";
        cin>>choice;

    }
    return 0;
}
```

## **Output :**

**1 for insert at beginning**  
**2 for insert at end**  
**3 for insert after the given value**  
**4 for delete from beginning**  
**5 delete from end**  
**6 delete the given value**  
**7 display**

**enter your choice : 1**

**enter the value : 5**

**enter your choice : 2**

**enter the value : 4**

**enter your choice : 7**

**5 4**

**no of nodes in the linked list are : 2**

**enter your choice : 1**

**enter the value : 3**

**enter your choice : 7**

**3 5 4**

**no of nodes in the linked list are : 3**

**enter your choice : 6**

**Enter the value to be deleted : 5**

**enter your choice : 7**

**3 4**

**no of nodes in the linked list are : 2**

**enter your choice : 4**

**Node Deleted**

**enter your choice : 7**

**4**

**no of nodes in the linked list are : 1**

**enter your choice : 5**

**Node Deleted**

**enter your choice : 7**

**no of nodes in the linked list are : 0**

**enter your choice :**

## Doubly Circular Linklist

```
#include<iostream>
#include<stdlib.h>
#include<new>

using namespace std;

class node{

public:

    int data;
    node *next;
    node *prev;
};

int getdata(){

    int value;
    cout<<"enter the value : ";
    cin>>value;
    return value;
}
void insert_atstart(node **head){

    int value = getdata();
    node *new_node = new node();
    new_node->data = value;
    if(*head == NULL){
        new_node->next = new_node;
        new_node->prev = new_node;
        (*head)=new_node;
    }
    else{
        node *last = (*head)->prev;
        new_node->data = value;
        new_node->next = (*head);
        new_node->prev = last;
        last->next = (*head)->prev = new_node;
        (*head) = new_node;
    }
}
```

```

}

void insert_atend(node **head)
{
    int value = getdata();
    node *new_node = new node();
    new_node->data = value;
    if(*head == NULL){
        new_node->next = new_node;
        new_node->prev = new_node;
        (*head)=new_node;
    }
    else{
        node *last = (*head)->prev;
        new_node->next = (*head);
        (*head)->prev = new_node;
        new_node->prev = last;
        last->next = new_node;
    }
}
void insert_afterval(node **head)
{
    int value = getdata();
    int uservalue;

    cout<<"enter the aftervalue :";
    cin>>uservalue;
    node *new_node = new node();
    new_node->data = value;
    node *temp = (*head);
    while (temp->data != uservalue)
        temp = temp->next;

    node *next_node = temp->next;
    temp->next = new_node;
    new_node->prev = temp;
    new_node->next = next_node;
    next_node->prev = new_node;
}
void delete_atstart(node **head)
{
    node *temp;
    if((*head) == NULL)

```

```

{
    cout<<"UNDERFLOW";
}
else if((*head)->next == (*head))
{
    (*head) = NULL;
    free(*head);
    cout<<"\n Node Deleted \n";
}
else
{
    temp = *head;
    while(temp->next != (*head))
        temp = temp->next;

    temp -> next = (*head) -> next;
    (*head) -> next -> prev = temp;
    free(head);
    (*head) = temp -> next;
    cout<<"\nNode Deleted\n";
}
}

void delete_atend(node **head)
{
    node *temp = *head;
    if((*head) == NULL)
    {
        cout<<"UNDERFLOW";
    }
    else if(temp->next == (*head))
    {
        (*head) = NULL;
        temp = temp->next;
        cout<<"\n Node Deleted \n";
    }
    else
    {
        while(temp->next != (*head))
        {
            temp = temp -> next;
        }
        temp -> prev -> next = (*head);
        (*head)->prev = temp->prev ;
        free(temp);
        cout<<"\nNode Deleted\n";
    }
}

```

```

    }

}

void delete_value(node **head)
{
    node *temp;
    int value;
    cout<<"Enter the value to be deleted : ";
    cin>>value;
    temp = *head;
    if(temp->data == value && temp->next == NULL){
        *head = NULL;
        free(temp);
        cout<<"list is empty";
    }
    else if(temp->data == value && temp->next != NULL){
        temp->next->prev = temp->next;
        temp->next->next = temp->next;
        (*head) = temp->next;
        free(temp);
    }
    else{

        while(temp->data != value && temp->next != (*head))
            temp = temp->next;

        if(temp == NULL){
            cout<<"value is not found";
        }
        else if(temp->next == NULL){
            temp->prev->next = (*head);
            (*head)->prev = temp->prev;
            free(temp);
        }
        else{
            temp->prev->next = temp->next;
            temp->next->prev = temp->prev;
            temp = temp->next;
        }
    }
}
void display(node* head)
{
    node *temp = head;

```

```

        while (temp->next != head)
    {
        cout<< temp->data<<" ";
        temp = temp->next;
    }
    cout<<temp->data;
}
int main()
{
    node *head = NULL;
    int choice;
    cout<<" 1 insert at beginning \n 2 insert at end \n 3 insert after the given
value \n 4 delete from beginning";
    cout<<"\n 5 delete from end \n 6 delete the given value \n 7 display \n";
    cout<<"enter your choice : ";
    cin>>choice;
    while(choice!=0){

        if(choice == 1){
            insert_atstart(&head);
        }
        else if(choice == 2){
            insert_atend(&head);
        }
        else if(choice == 3){
            insert_afterval(&head);
        }
        else if(choice == 4){
            delete_atstart(&head);
        }
        else if(choice == 5){
            delete_atend(&head);
        }
        else if(choice == 6){
            delete_value(&head);
        }
        else if(choice == 7){
            display(head);
        }
        else{
            cout<<"incorrect choice";
            cout<<"enter your choice : ";
            cin>>choice;
        }
        cout<<"\n enter your choice : ";
    }
}

```

```
    cin>>choice;

}

return 0;
}
```

## Output :

**1 for insert at beginning**  
**2 for insert at end**  
**3 for insert after the given value**  
**4 for delete from beginning**  
**5 delete from end**  
**6 delete the given value**  
**7 display**

**enter your choice : 1**

**enter the value : 3**

**enter your choice : 2**

**enter the value : 9**

**enter your choice : 7**

**3 9**

**no of nodes in the linked list are : 2**

**enter your choice : 1**

**enter the value : 5**

**enter your choice : 7**

**5 3 9**

**no of nodes in the linked list are : 3**

**enter your choice : 6**

**Enter the value to be deleted : 5**

**enter your choice : 7**

**3 9**

**no of nodes in the linked list are : 2**

**enter your choice : 4**

**Node Deleted**

**enter your choice : 7**

**9**

**no of nodes in the linked list are : 1**

**enter your choice : 5**

**Node Deleted**

**enter your choice : 7**

**no of nodes in the linked list are : 0**

**enter your choice :**

## Perform Bubble, selection, insertion sort

```
#include<iostream>
using namespace std;
class Sorting{
public:
    int list[10], i;

    void getData() {
        i = 0;
        while(i < 10){
            cout << "Enter The " << i << " index element : ";
            cin >> list[i];
            i++;
        }
    }

    void print() {
        i = 0;
        while(i < 10){
            cout << "The Element At index" << i << " : " << list[i] <<
endl;
            i++;
        }
    }

    void bubblesort() {
        for(i = 0; i < 10 - 1; i++) {
            for(int j = 0; j < 10 - i - 1; j++) {
                if(list[j] > list[j+1]) {
                    list[j] += list[j+1];
                    list[j+1] = list[j] - list[j+1];
                    list[j] -= list[j+1];
                }
            }
        }
        print();
    }
}
```

```

void selectionsort() {
    int lowest_index;
    for(i = 0; i < 10 - 1; i++) {
        lowest_index = i;
        for(int j = i + 1; j < 10; j++) {
            if(list[j] < list[lowest_index]) {
                lowest_index = j;
            }
        }
        list[i] += list[lowest_index];
        list[lowest_index] = list[i] - list[lowest_index];
        list[i] -= list[lowest_index];
    }
    print();
}

void insertionsort() {
    int found_low;
    for(i = 1; i < 10 - 1; i++) {
        if( list[i-1] > list[i] ){
            int j = i - 1;
            found_low = list[i];
            while(j >= 0 && list[j] > list[i]){
                list[j + 1] = list[j];
                j--;
            }
            list[j + 1] = found_low;
        }
    }
    print();
}

int main(){
    Sorting s;
    s.getData();
    int choice = 0;
    while(1){

```

```
    cout << "1. Perform Bubble Sort." << endl << "2. Perform Selection Sort." << endl << "3. Perform Insertion Sort." << endl << "4. Reinsert Data into Array." << endl << "5. Exit." << endl;
    cin >> choice;
    switch(choice){
        case 1:
            s.bubblesort();
            break;
        case 2:
            s.selectionsort();
            break;
        case 3:
            s.insertionsort();
            break;
        case 4:
            s.getData();
            break;
        case 5:
            exit(0);
        default:
            cout << "Invalid Choice" << endl;
    }
}
```

Ouput :

PS E:\MCA\MCA SEM 3\DS> .\bubblesort.exe

Enter The 0 index element : 45

Enter The 1 index element : 12

Enter The 2 index element : 34

Enter The 3 index element : 87

Enter The 4 index element : 3

Enter The 5 index element : 6

Enter The 6 index element : 9

Enter The 7 index element : 10

Enter The 8 index element : 17

Enter The 9 index element : 23

1. Perform Bubble Sort.
2. Perform Selection Sort.
3. Perform Insertion Sort.
4. Re-insert Data into Array.
5. Exit.

1

The Element At index0 : 3

The Element At index1 : 6

The Element At index2 : 9

The Element At index3 : 10

The Element At index4 : 12

The Element At index5 : 17

The Element At index6 : 23

The Element At index7 : 34

The Element At index8 : 45

The Element At index9 : 87

1. Perform Bubble Sort.
2. Perform Selection Sort.
3. Perform Insertion Sort.
4. Re-insert Data into Array.
5. Exit.

5

## Linear Search

```
#include<iostream>
using namespace std;

class Linear{
public:
    int arr[10];
    int i = 0;

    Linear(){
        getData();
    }

    void getData(){
        i = 0;
        cout << "Enter Values In array : ";
        while(i != 10){
            cin >> arr[i];
            i++;
        }
    }

    int getNumber(){
        int n;
        cout << "Enter Values You want to Search : ";
        cin >> n;
        return n;
    }

    int linearsearch(int n) {
        i = 0;
        while(i != 10){
            if(arr[i] == n) {
                return i;
            }
            i++;
        }
        return -1;
    }
};

int main(){
    Linear l;
    char ch;
    while(1){

        int search = l.getNumber();
        int result = l.linearsearch(search);
```

```
        if(result < 0) cout << "Value Not Present in Array List." << endl;
        else cout << "Search Value Located At " << result << " index of the array" << endl;
    }
    cout << "Press '/c/' for continue search (Any other character than '/c/' will exit the Program) : ";
    cin >> ch;
    if(ch != 'c')
        exit(0);
}
}
```

## Output :

PS E:\MCA\MCA SEM 3\DS\40%> .\linear.exe

Enter Values In array : 21

12

34

8

5

40

39

20

11

1

Enter Values You want to Search : 12

Search Value Located At 1 index of the array

Press '/c/' for continue search (Any other character than '/c/' will exit the Program) : c

Enter Values You want to Search : 34

Search Value Located At 2 index of the array

Press '/c/' for continue search (Any other character than '/c/' will exit the Program) : c

Enter Values You want to Search : 21

Search Value Located At 0 index of the array

Press '/c/' for continue search (Any other character than '/c/' will exit the Program) : c

Enter Values You want to Search : 1

Search Value Located At 9 index of the array

Press '/c/' for continue search (Any other character than '/c/' will exit the Program) : c

Enter Values You want to Search : 5

Search Value Located At 4 index of the array

Press '/c/' for continue search (Any other character than '/c/' will exit the Program) : z

## Binary Search

```
#include<iostream>
using namespace std;

class Binary{
public:
    int arr[10];
    int i = 0;

    Binary(){
        getData();
    }

    void getData(){
        i = 0;
        cout << "Enter Values In array : ";
        while(i != 10){
            cin >> arr[i];
            i++;
        }
    }
}
```

```

int getNumber(){
    int n;
    cout << "Enter Values You want to Search : ";
    cin >> n;
    return n;
}

int binarySearch(int n) {
    i = 0;
    int j = 9;
    while(j >= i){
        int k = (i+j)/2;
        if(arr[k] < n){
            i = k + 1;
        }
        else if (arr[k] > n) {
            j = k - 1;
        }
        else{
            return k;
        }
    }
    return -1;
};

int main(){
    Binary l;
    char ch;
    while(1){

        int search = l.getNumber();
        int result = l.binarySearch(search);
        if(result < 0) cout << "Value Not Present in Array List." << endl;
        else cout << "Search Value Located At " << result << " index of the array" << endl;
        cout << "Press '/c/' for continue search (Any other character than '/c/' will exit the Program) : ";
        cin >> ch;
        if(ch != 'c')
            exit(0);
    }
}

```

## Output :

PS E:\MCA\MCA SEM 3\DS\40%> .\Binary.exe

Enter Values In array : 10

12

14

18

19

22

47

49

62

81

Enter Values You want to Search : 12

Search Value Located At 1 index of the array

Press '/c/' for continue search (Any other character than '/c/' will exit the Program) : c

Enter Values You want to Search : 31

Value Not Present in Array List.

Press '/c/' for continue search (Any other character than '/c/' will exit the Program) : c

Enter Values You want to Search : 62

Search Value Located At 8 index of the array

Press '/c/' for continue search (Any other character than '/c/' will exit the Program) : m

## Expression Tree

```
#include<iostream>
#include<cstring>
using namespace std;

class Stack {

    class Value {
        public:
            string data;
            Value *Next;

            Value(char n) {
                data = n;
                Next = NULL;
            }
    };

    Value *top;
    int size, count;

    public:

        Stack(int size)
        {
            if (size < 1)
                size = 5;
            this->size = size;
            count = 0;
            top = NULL;
        }

        bool isFull(){
            return (count >= size);
        }

        bool isEmpty(){
            return !top;
        }

        void push(char n){
            if(isFull()){
                cout << "Overflowed" << endl;
                return;
            }
            Value *val = new Value(n);
```

```

        val->Next = top;
        top = val;
        count++;
    }

    void edit(char n){
        if(isEmpty()) {
            cout << "UnderFlowed" << endl;
        }
        top->Next->data += n;
        string poped = pop();
        top->data += poped;
    }

    string pop() {
        string lastdelete = top->data;
        top = top->Next;
        count--;
        return lastdelete;
    }

    void display() {
        if(isEmpty())
            cout << "Empty" << endl;
        else
            cout << top->data << endl;
    }

    bool isOperator(char c)
    {
        if (c == '+' || c == '-' || c == '*' || c == '/' || c == '^') return true;

        return false;
    }
};

int main(){
    char Post_Expresion[] = "ab+cd/+efg*-*";
    int i = 0,length = strlen(Post_Expresion);
    Stack s(length);

    while(Post_Expresion[i] != '\0') {
        if(s.isOperator(Post_Expresion[i])){
            s.edit(Post_Expresion[i]);
        }
        else {
            s.push(Post_Expresion[i]);
        }
        i++;
    }
}

```

```
    s.display();
    return 0;
}
```

**Output :**

PS E:\MCA\MCA SEM 3\DS\40%> .\Expression.exe

a+b+c/d\*e-f\*g

## Binary Search Tree

```
#include<iostream>
using namespace std;

struct tree{
    int data;
    tree *left,*right;
};

// method declaration
void menu(struct tree *);
struct tree * construct(struct tree *);
void preorder(struct tree *);
void postorder(struct tree *);
void inorder(struct tree *);
void minmax(struct tree *,int []);
void searching(struct tree *);
bool advancesearch(struct tree *,int );
struct tree * insert(struct tree *);
struct tree * deleteNode(struct tree *,int );
struct tree * minfromRight(struct tree * );

int main(){
    struct tree *head = NULL;
    menu(head);
    return 0;
}

void menu(struct tree *head) {
    int listen = 0;
    while(1){
        cout << endl << "1. Create Tree" << endl << "2. PreOrder Traversal" << endl << "3
. PostOrder Traversal" << endl << "4. InOrder Traversal" << endl << "5. Insertion" << endl
<< "6. Searching" << endl << "7. Find Minimum & Maximum" << endl << "8. Deletion" << endl
<< "9. Exit" << endl << "Enter Your Choice : ";
        cin >> listen;
        switch (listen)
        {
        case 1:
            head = construct(head);
            break;
        case 2:
            preorder(head);
            break;
        case 3:
            postorder(head);
            break;
```

```

        case 4:
            inorder(head);
            break;
        case 5:
            head = insert(head);
            break;
        case 6:
            searching(head);
            break;
        case 7:
        {
            int m[2] = {head->data};
            minmax(head,m);
            cout << "Minimum From Tree is : " << m[0] << endl;
            cout << "Maximum From Tree is : " << m[1] << endl;
        }
        break;
    case 8:
    {
        int value;
        cout << "Enter The Number You want to delete : ";
        cin >> value;
        head = deleteNode(head,value);
    }
    break;
}
case 9:
    exit(0);
default:
    cout << "Select Valid Options." << endl;
    menu(head);
}

void preorder(struct tree *head) {
    struct tree *temp;
    temp = head;
    if(temp == NULL)
        return;

    cout << temp->data << " ";
    preorder(temp->left);
    preorder(temp->right);
}

void postorder(struct tree *head) {
    struct tree *temp;
    temp = head;
    if(temp == NULL)
        return;
}

```

```

postorder(temp->left);
postorder(temp->right);
cout << temp->data << " ";
}

void inorder(struct tree *head) {
    struct tree *temp;
    temp = head;
    if(temp == NULL)
        return;

    inorder(temp->left);
    cout << temp->data << " ";
    inorder(temp->right);
}

void minmax(struct tree *head,int m[]) {
    struct tree *temp;
    temp = head;
    if(temp == NULL)
        return;

    preorder(temp->left);
    if(temp->data < m[0])
        m[0] = temp->data;
    if(temp->data > m[1])
        m[1] = temp->data;
    preorder(temp->right);
}

void searching(struct tree *head) {
    bool found = false;
    int getNum;
    cout << "Enter the Number You want to find from tree : ";
    cin >> getNum;

    if(head == NULL) {
        cout << "The Tree is Empty." << endl;
        return;
    }
    found = advancesearch(head,getNum);
    if(found)
        cout << "The Number You searching is present in the tree" << endl;
    else
        cout << "The Number You searching is not present in the tree" << endl;
}

bool advancesearch(struct tree *head,int getNum) {
    struct tree *temp;

```

```

temp = head;
bool found = false;
if(temp == NULL)
    return false;

advancesearch(temp->left,getNum);
if(temp->data == getNum) {
    return true;
}
advancesearch(temp->right,getNum);
return false;
}

struct tree * construct(struct tree *head) {
int i = 0;
cout << "Total Data You Want : ";
cin >> i;
while(i > 0) {
    head = insert(head);
    i--;
}
return head;
}

struct tree * insert(struct tree *head) {
    bool target = false;
    int input;
    struct tree *n,*temp;
    temp = head;
    cout << "Enter Value : ";
    cin >> input;
    n = (struct tree *)malloc(sizeof(struct tree));

    if(head == NULL){
        head = n;
    }
    else {
        while(!target) {
            if(temp->data > input && temp->left != NULL){
                temp = temp->left;
            }
            else if(temp->data < input && temp->right != NULL ) {
                temp = temp->right;
            }

            if((temp->data < input && temp->right == NULL) || (temp-
>data > input && temp->left == NULL)) {
                target = true;
            }
        }
    }
}

```

```

        if(temp->data < input) {
            temp->right = n;
        }
        else {
            temp->left = n;
        }
    }
    n->data = input;
    n->left = n->right = NULL;
    return head;
}

struct tree * deleteNode(struct tree* head, int deletethis) {
    struct tree *temp;
    temp = head;
    if (temp == NULL)
        return temp;

    if (deletethis < temp->data)
        temp->left = deleteNode(temp->left, deletethis);

    else if (deletethis > temp->data)
        temp->right = deleteNode(temp->right, deletethis);

    else
    {
        if (temp->left == NULL)
        {
            struct tree *temp2 = temp->right;
            free(temp);
            return temp2;
        }
        else if (temp->right == NULL)
        {
            struct tree *temp2 = temp->left;
            free(temp);
            return temp2;
        }

        struct tree* temp2 = minfromRight(temp->right);

        temp->data = temp2->data;

        temp->right = deleteNode(temp->right, temp2->data);
    }
    return temp;
}

struct tree * minfromRight(struct tree* temp) {
    struct tree* current = temp;

```

```
    while (current && current->left != NULL)
        current = current->left;

    return current;
}
```

## **Output :**

PS E:\MCA\MCA SEM 3\DS\40%> .\BST.exe

1. Create Tree
2. PreOrder Traversal
3. PostOrder Traversal
4. InOrder Traversal
5. Insertion
6. Searching
7. Find Minimum & Maximum
8. Deletion
9. Exit

Enter Your Choice : 1

Total Data You Want : 5

Enter Value : 4

Enter Value : 2

Enter Value : 3

Enter Value : 7

Enter Value : 5

1. Create Tree

- 2. PreOrder Traversal
- 3. PostOrder Traversal
- 4. InOrder Traversal
- 5. Insertion
- 6. Searching
- 7. Find Minimum & Maximum
- 8. Deletion
- 9. Exit

Enter Your Choice : 2

4 2 3 7 5

- 1. Create Tree
- 2. PreOrder Traversal
- 3. PostOrder Traversal
- 4. InOrder Traversal
- 5. Insertion
- 6. Searching
- 7. Find Minimum & Maximum
- 8. Deletion
- 9. Exit

Enter Your Choice : 3

3 2 5 7 4

- 1. Create Tree
- 2. PreOrder Traversal
- 3. PostOrder Traversal
- 4. InOrder Traversal

- 5. Insertion
- 6. Searching
- 7. Find Minimum & Maximum
- 8. Deletion
- 9. Exit

Enter Your Choice : 4

2 3 4 5 7

- 1. Create Tree
- 2. PreOrder Traversal
- 3. PostOrder Traversal
- 4. InOrder Traversal
- 5. Insertion
- 6. Searching

7. Find Minimum & Maximum

- 8. Deletion
- 9. Exit

Enter Your Choice : 5

Enter Value : 6

- 1. Create Tree
- 2. PreOrder Traversal
- 3. PostOrder Traversal
- 4. InOrder Traversal
- 5. Insertion
- 6. Searching

7. Find Minimum & Maximum

8. Deletion

9. Exit

Enter Your Choice : 4

2 3 4 5 6 7

1. Create Tree

2. PreOrder Traversal

3. PostOrder Traversal

4. InOrder Traversal

5. Insertion

6. Searching

7. Find Minimum & Maximum

8. Deletion

9. Exit

Enter Your Choice : 6

Enter the Number You want to find from tree : 5

The Number You searching is present in the tree

1. Create Tree

2. PreOrder Traversal

3. PostOrder Traversal

4. InOrder Traversal

5. Insertion

6. Searching

7. Find Minimum & Maximum

8. Deletion

9. Exit

Enter Your Choice : 7

Minimum From Tree is : 2

Maximum From Tree is : 7

1. Create Tree

2. PreOrder Traversal

3. PostOrder Traversal

4. InOrder Traversal

5. Insertion

6. Searching

7. Find Minimum & Maximum

8. Deletion

9. Exit

Enter Your Choice : 8

Enter The Number You want to delete : 5

1. Create Tree

2. PreOrder Traversal

3. PostOrder Traversal

4. InOrder Traversal

5. Insertion

6. Searching

7. Find Minimum & Maximum

8. Deletion

9. Exit

Enter Your Choice : 4

2 3 4 6 7

1. Create Tree

2. PreOrder Traversal

3. PostOrder Traversal

4. InOrder Traversal

5. Insertion

6. Searching

7. Find Minimum & Maximum

8. Deletion

9. Exit

Enter Your Choice : 2

4 2 3 7 6

1. Create Tree

2. PreOrder Traversal

3. PostOrder Traversal

4. InOrder Traversal

5. Insertion

6. Searching

7. Find Minimum & Maximum

8. Deletion

9. Exit

Enter Your Choice : 9

## Graph Adjacent Node

```
#include <iostream>
using namespace std;

struct adjNode {
    int val, cost;
    adjNode* next;
};

struct graphEdge {
    int start_ver, end_ver, weight;
};

class DiaGraph{

    adjNode* getAdjListNode(int value, int weight, adjNode* head)  {
        adjNode* newNode = new adjNode;
        newNode->val = value;
        newNode->cost = weight;

        newNode->next = head;
        return newNode;
    }

    int N;
public:
    adjNode **head;

    DiaGraph(graphEdge edges[], int n, int N)  {

        head = new adjNode*[N]();
        this->N = N;

        for (int i = 0; i < N; ++i)
            head[i] = nullptr;

        for (unsigned i = 0; i < n; i++)  {
```

```

        int start_ver = edges[i].start_ver;
        int end_ver = edges[i].end_ver;
        int weight = edges[i].weight;

                adjNode* newNode = getAdjListNode(end_ver, weight,
t, head[start_ver]);

        head[start_ver] = newNode;
    }

}

~DiaGraph() {
for (int i = 0; i < N; i++)
    delete[] head[i];
    delete[] head;
}
};

void display_AdjList(adjNode* ptr, int i)
{
    while (ptr != nullptr) {
        cout << "(" << i << ", " << ptr->val
            << ", " << ptr->cost << ") ";
        ptr = ptr->next;
    }
    cout << endl;
}

int main()
{

graphEdge edges[ ] = {

    {0,1,2},{0,2,4},{1,4,3},{2,3,2},{3,1,4},{4,3,3}
};
int N = 6;

```

```
int n = sizeof(edges)/sizeof(edges[0]);  
  
DiaGraph diagraph(edges, n, N);  
  
cout<<"Graph adjacency list "<<endl<<(start_vertex, end  
_vertex, weight):"<<endl;  
for (int i = 0; i < N; i++)  
{  
  
    display_AdjList(diagraph.head[i], i);  
}  
return 0;  
}
```

### Output:

```
E:\PRADIP\DataStructureInC++>cd "e:\PRADIP\DataStructureInC++\" && g++ graphAd  
jacentNode.c++ -o graphAdjacentNode && "e:\PRADIP\DataStructureInC++\"graphAdj  
acentNode  
Graph adjacency list  
(start_vertex, end_vertex, weight):  
(0, 2, 4) (0, 1, 2)  
(1, 4, 3)  
(2, 3, 2)  
(3, 1, 4)  
(4, 3, 3)
```

```
E:\PRADIP\DataStructureInC++>
```

Ln 3, Col 1 Spaces: 4 UTF-8 CRLF C++ Win32 ⚙️ 🔔

## Unweighted Graph Shortest path

```
#include <bits/stdc++.h>
using namespace std;

void add_edge(vector<int> adj[], int src, int dest)
{
    adj[src].push_back(dest);
    adj[dest].push_back(src);
}

bool BFS(vector<int> adj[], int src, int dest, int v,
         int pred[], int dist[])
{
    list<int> queue;

    bool visited[v];

    for (int i = 0; i < v; i++) {
        visited[i] = false;
        dist[i] = INT_MAX;
        pred[i] = -1;
    }

    visited[src] = true;
    dist[src] = 0;
    queue.push_back(src);

    while (!queue.empty()) {
        int u = queue.front();
```

```

queue.pop_front();
for (int i = 0; i < adj[u].size(); i++) {
    if (visited[adj[u][i]] == false) {
        visited[adj[u][i]] = true;
        dist[adj[u][i]] = dist[u] + 1;
        pred[adj[u][i]] = u;
        queue.push_back(adj[u][i]);
    }
}

if (adj[u][i] == dest)
    return true;
}
}

return false;
}

void printShortestDistance(vector<int> adj[], int s,
                           int dest, int v)
{
    int pred[v], dist[v];

    if (BFS(adj, s, dest, v, pred, dist) == false) {
        cout << "Given source and destination"
             << " are not connected";
        return;
    }

    vector<int> path;
    int crawl = dest;
    path.push_back(crawl);
    while (pred[crawl] != -1) {
        path.push_back(pred[crawl]);
        crawl = pred[crawl];
    }
}

```

```
}

cout << "Shortest path length is : "
     << dist[dest];

cout << "\nPath is::\n";
for (int i = path.size() - 1; i >= 0; i--)
    cout << path[i] << " ";
}

int main()
{
    int v = 8;

    vector<int> adj[v];

    add_edge(adj, 0, 1);
    add_edge(adj, 0, 3);
    add_edge(adj, 1, 2);
    add_edge(adj, 3, 4);
    add_edge(adj, 3, 7);
    add_edge(adj, 4, 5);
    add_edge(adj, 4, 6);
    add_edge(adj, 4, 7);
    add_edge(adj, 5, 6);
    add_edge(adj, 6, 7);
    int source = 0, dest = 7;
    printShortestDistance(adj, source, dest, v);
    return 0;
}
```

## Output:

```
E:\PRADIP\DataStructureInC++>cd "e:\PRADIP\DataStructureInC++\" && g++ shortPa  
thUsingQ.c++ -o shortPathUsingQ && "e:\PRADIP\DataStructureInC++\"shortPathUsi  
ngQ  
Shortest path length is : 2  
Path is::  
0 3 7  
E:\PRADIP\DataStructureInC++>
```

Ln 3, Col 1 Spaces: 4 UTF-8 CRLF C++ Win32 ⚙️ 🔔

## Unweighted Graph Shortest path using Queue

```
#include <iostream>
using namespace std;

void add_edge(vector<int> adj[], int src, int dest)
{
    adj[src].push_back(dest);
    adj[dest].push_back(src);
}

bool BFS(vector<int> adj[], int src, int dest, int v,
         int pred[], int dist[])
{
    list<int> queue;

    bool visited[v];

    for (int i = 0; i < v; i++) {
        visited[i] = false;
        dist[i] = INT_MAX;
        pred[i] = -1;
    }

    visited[src] = true;
    dist[src] = 0;
    queue.push_back(src);

    while (!queue.empty()) {
        int u = queue.front();
```

```

queue.pop_front();
for (int i = 0; i < adj[u].size(); i++) {
    if (visited[adj[u][i]] == false) {
        visited[adj[u][i]] = true;
        dist[adj[u][i]] = dist[u] + 1;
        pred[adj[u][i]] = u;
        queue.push_back(adj[u][i]);
    }
}

if (adj[u][i] == dest)
    return true;
}
}

return false;
}

void printShortestDistance(vector<int> adj[], int s,
                           int dest, int v)
{
    int pred[v], dist[v];

    if (BFS(adj, s, dest, v, pred, dist) == false) {
        cout << "Given source and destination"
             << " are not connected";
        return;
    }

    vector<int> path;
    int crawl = dest;
    path.push_back(crawl);
    while (pred[crawl] != -1) {
        path.push_back(pred[crawl]);
        crawl = pred[crawl];
    }
}

```

```
}

cout << "Shortest path length is : "
     << dist[dest];

cout << "\nPath is::\n";
for (int i = path.size() - 1; i >= 0; i--)
    cout << path[i] << " ";
}

int main()
{
    int v = 8;

    vector<int> adj[v];

    add_edge(adj, 0, 1);
    add_edge(adj, 0, 3);
    add_edge(adj, 1, 2);
    add_edge(adj, 3, 4);
    add_edge(adj, 3, 7);
    add_edge(adj, 4, 5);
    add_edge(adj, 4, 6);
    add_edge(adj, 4, 7);
    add_edge(adj, 5, 6);
    add_edge(adj, 6, 7);
    int source = 0, dest = 7;
    printShortestDistance(adj, source, dest, v);
    return 0;
}
```

## Output:

```
E:\PRADIP\DataStructureInC++>cd "e:\PRADIP\DataStructureInC++\" && g++ shortPa  
thUsingQ.c++ -o shortPathUsingQ && "e:\PRADIP\DataStructureInC++\"shortPathUsi  
ngQ  
Shortest path length is : 2  
Path is::  
0 3 7  
E:\PRADIP\DataStructureInC++>
```

Ln 3, Col 1 Spaces: 4 UTF-8 CRLF C++ Win32 ⚙️ 🔔

## Dijkstra's Weighted Graph Shortest Path

```
#include <limits.h>
#include <stdio.h>

#define V 9

int minDistance(int dist[], bool sptSet[])
{
    int min = INT_MAX, min_index;

    for (int v = 0; v < V; v++)
        if (sptSet[v] == false && dist[v] <= min)
            min = dist[v], min_index = v;

    return min_index;
}

void printSolution(int dist[])
{
    printf("Vertex \t\t Distance from Source\n");
    for (int i = 0; i < V; i++)
        printf("%d \t\t %d\n", i, dist[i]);
}

void dijkstra(int graph[V][V], int src)
{
    int dist[V];

    bool sptSet[V];
```



```
        { 0, 0, 0, 0, 0, 2, 0, 1, 6 },
        { 8, 11, 0, 0, 0, 0, 1, 0, 7 },
        { 0, 0, 2, 0, 0, 0, 6, 7, 0 } };

dijkstra(graph, 0);

return 0;
}
```

### Output:

```
E:\PRADIP\DataStructureInC++>cd "e:\PRADIP\DataStructureInC++\" && g++ dijkstra
a.c++ -o dijkstra && "e:\PRADIP\DataStructureInC++\"dijkstra
Vertex      Distance from Source
0            0
1            4
2            12
3            19
4            21
5            11
6            9
7            8
8            14
```

E:\PRADIP\DataStructureInC++>

Ln 4, Col 1 Spaces: 4 UTF-8 CRLF C++ Win32 ⚙️ 🔔

## Priority Queue using Min Heap

```
#include <iostream>
using namespace std;

int main ()
{
    priority_queue <int> pq;
    pq.push(5);
    pq.push(1);
    pq.push(10);
    pq.push(30);
    pq.push(20);

    while (pq.empty() == false)
    {
        cout << pq.top() << " ";
        pq.pop();
    }

    return 0;
}
```

Output:

```
E:\PRADIP\DataStructureInC++>cd "e:\PRADIP\DataStructureInC++\" && g++ priorit
yQUsingMinHeap.c++ -o priorityQUsingMinHeap && "e:\PRADIP\DataStructureInC++\"
priorityQUsingMinHeap
30 20 10 5 1
E:\PRADIP\DataStructureInC++>
```

Ln 4, Col 1 Spaces: 4 UTF-8 CRLF C++ Win32 ⚙️ 🔍

## Max Heap

```
#include <iostream>
using namespace std;

int main ()
{
    priority_queue <int> pq;
    pq.push(5);
    pq.push(1);
    pq.push(10);
    pq.push(30);
    pq.push(20);

    while (pq.empty() == false)
    {
        cout << pq.top() << " ";
        pq.pop();
    }

    return 0;
}
```

### Output:

```
E:\PRADIP\DataStructureInC++>cd "e:\PRADIP\DataStructureInC++\" && g++ maxHe
ap.cpp -o maxHeap && "e:\PRADIP\DataStructureInC++\"maxHeap
30 20 10 5 1
E:\PRADIP\DataStructureInC++>
```

## Heap sort

```
#include <iostream>

using namespace std;

void heapify(int arr[], int n, int i)
{
    int largest = i;
    int l = 2 * i + 1;
    int r = 2 * i + 2;

    if (l < n && arr[l] > arr[largest])
        largest = l;

    if (r < n && arr[r] > arr[largest])
        largest = r;

    if (largest != i) {
        swap(arr[i], arr[largest]);

        heapify(arr, n, largest);
    }
}

void heapSort(int arr[], int n)
{
    for (int i = n / 2 - 1; i >= 0; i--)
        heapify(arr, n, i);
```

```
for (int i = n - 1; i > 0; i--) {  
  
    swap(arr[0], arr[i]);  
    heapify(arr, i, 0);  
}  
}  
  
  
void printArray(int arr[], int n)  
{  
    for (int i = 0; i < n; ++i)  
        cout << arr[i] << " ";  
    cout << "\n";  
}  
  
  
int main()  
{  
    int arr[] = { 12, 11, 13, 5, 6, 7 };  
    int n = sizeof(arr) / sizeof(arr[0]);  
  
    heapSort(arr, n);  
  
    cout << "Sorted array is \n";  
    printArray(arr, n);  
}
```

## Output:

```
E:\PRADIP\DataStructureInC++>cd "e:\PRADIP\DataStructureInC++\" && g++ heapSort.c++ -o heapSort && "e:\PRADIP\DataStructureInC++\"heapSort  
Sorted array is  
5 6 7 11 12 13
```

```
E:\PRADIP\DataStructureInC++>
```

Ln 62, Col 2 (995 selected) Spaces: 4 UTF-8 CRLF C++ Win32 ⌂ ⓘ

## Quick Sort

```
#include <iostream>
using namespace std;

void swap(int* a, int* b)
{
    int t = *a;
    *a = *b;
    *b = t;
}

int partition (int arr[], int low, int high)
{
    int pivot = arr[high];
    int i = (low - 1);

    for (int j = low; j <= high - 1; j++)
    {
        if (arr[j] < pivot)
        {
            i++;
            swap(&arr[i], &arr[j]);
        }
    }
    swap(&arr[i + 1], &arr[high]);
    return (i + 1);
}

void quickSort(int arr[], int low, int high)
{
    if (low < high)
    {
```

```
        int pi = partition(arr, low, high);

        quickSort(arr, low, pi - 1);
        quickSort(arr, pi + 1, high);
    }
}

void printArray(int arr[], int size)
{
    int i;
    for (i = 0; i < size; i++)
        cout << arr[i] << " ";
    cout << endl;
}

int main()
{
    int arr[] = {10, 7, 8, 9, 1, 5};
    int n = sizeof(arr) / sizeof(arr[0]);
    quickSort(arr, 0, n - 1);
    cout << "Sorted array: \n";
    printArray(arr, n);
    return 0;
}
```

## Output:

```
E:\PRADIP\DataStructureInC++>cd "e:\PRADIP\DataStructureInC++\" && g++ quickSo  
rt.c++ -o quickSort && "e:\PRADIP\DataStructureInC++\"quickSort  
Sorted array:  
1 5 7 8 9 10
```

```
E:\PRADIP\DataStructureInC++>
```

Ln 62, Col 4 (1150 selected) Spaces: 4 UTF-8 CRLF C++ Win32 ⌂ ⌂

## Radix Sort

```
#include <iostream>
using namespace std;

int getMax(int arr[], int n)
{
    int mx = arr[0];
    for (int i = 1; i < n; i++)
        if (arr[i] > mx)
            mx = arr[i];
    return mx;
}

void countSort(int arr[], int n, int exp)
{
    int output[n];
    int i, count[10] = { 0 };

    for (i = 0; i < n; i++)
        count[(arr[i] / exp) % 10]++;
}

for (i = 1; i < 10; i++)
    count[i] += count[i - 1];

for (i = n - 1; i >= 0; i--) {
    output[count[(arr[i] / exp) % 10] - 1] = arr[i];
    count[(arr[i] / exp) % 10]--;
}

for (i = 0; i < n; i++)
    arr[i] = output[i];
```

```

}

void radixsort(int arr[], int n)
{
    int m = getMax(arr, n);

    for (int exp = 1; m / exp > 0; exp *= 10)
        countSort(arr, n, exp);
}

void print(int arr[], int n)
{
    for (int i = 0; i < n; i++)
        cout << arr[i] << " ";
}

int main()
{
    int arr[] = { 170, 45, 75, 90, 802, 24, 2, 66 };
    int n = sizeof(arr) / sizeof(arr[0]);

    radixsort(arr, n);
    print(arr, n);
    return 0;
}

```

### Output:

```

E:\PRADIP\DataStructureInC++>cd "e:\PRADIP\DataStructureInC++\" && g++ radixSo
rt.c++ -o radixSort && "e:\PRADIP\DataStructureInC++\"radixSort
2 24 45 66 75 90 170 802

```

## Shell sort

```
#include <iostream>
using namespace std;

int shellSort(int arr[], int n)
{
    for (int gap = n/2; gap > 0; gap /= 2)
    {
        for (int i = gap; i < n; i += 1)
        {
            int temp = arr[i];

            int j;
            for (j = i; j >= gap && arr[j - gap] > temp; j -
= gap)
                arr[j] = arr[j - gap];

            arr[j] = temp;
        }
    }
    return 0;
}

void printArray(int arr[], int n)
{
    for (int i=0; i<n; i++)
        cout << arr[i] << " ";
}

int main()
```

```
{  
    int arr[] = {12, 34, 54, 2, 3}, i;  
    int n = sizeof(arr)/sizeof(arr[0]);  
  
    cout << "Array before sorting: \n";  
    printArray(arr, n);  
  
    shellSort(arr, n);  
  
    cout << "\nArray after sorting: \n";  
    printArray(arr, n);  
  
    return 0;  
}
```

### Output:

```
E:\PRADIP\DataStructureInC++>cd "e:\PRADIP\DataStructureInC++\" && g++ shellSort.c++ -o shellShort && "e:\PRADIP\DataStructureInC++\"shellShort  
Array before sorting:  
12 34 54 2 3  
Array after sorting:  
2 3 12 34 54  
E:\PRADIP\DataStructureInC++>
```

Ln 5, Col 33 Spaces: 4 UTF-8 CRLF C++ Win32 ⚙️ 🔔

## Merge sort

```
#include <iostream>
using namespace std;

void merge(int arr[], int l, int m, int r)
{
    int n1 = m - l + 1;
    int n2 = r - m;

    int L[n1], R[n2];

    for (int i = 0; i < n1; i++)
        L[i] = arr[l + i];
    for (int j = 0; j < n2; j++)
        R[j] = arr[m + 1 + j];

    int i = 0;

    int j = 0;

    int k = l;

    while (i < n1 && j < n2) {
        if (L[i] <= R[j]) {
            arr[k] = L[i];
            i++;
        }
        else {
            arr[k] = R[j];
            j++;
        }
        k++;
    }

    while (i < n1) {
        arr[k] = L[i];
        i++;
        k++;
    }

    while (j < n2) {
        arr[k] = R[j];
        j++;
        k++;
    }
}
```

```
        }
        k++;
    }

    while (i < n1) {
        arr[k] = L[i];
        i++;
        k++;
    }

    while (j < n2) {
        arr[k] = R[j];
        j++;
        k++;
    }
}

void mergeSort(int arr[],int l,int r){
    if(l>=r){
        return;
    }
    int m = (l+r-1)/2;
    mergeSort(arr,l,m);
    mergeSort(arr,m+1,r);
    merge(arr,l,m,r);
}

void printArray(int A[], int size)
{
    for (int i = 0; i < size; i++)
        cout << A[i] << " ";
}
```

```
int main()
{
    int arr[] = { 12, 11, 13, 5, 6, 7 };
    int arr_size = sizeof(arr) / sizeof(arr[0]);

    cout << "Given array is \n";
    printArray(arr, arr_size);

    mergeSort(arr, 0, arr_size - 1);

    cout << "\nSorted array is \n";
    printArray(arr, arr_size);
    return 0;
}
```

### Output:

```
E:\PRADIP\DataStructureInC++>cd "e:\PRADIP\DataStructureInC++\" && g++ mergeSort.c++ -o mergeSort && "e:\PRADIP\DataStructureInC++\"mergeSort
Given array is
12 11 13 5 6 7
Sorted array is
5 6 7 11 12 13
E:\PRADIP\DataStructureInC++>
```

Ln 59, Col 6 Spaces:4 UTF-8 CRLF C++ Win32 ⚙️ 🔔

## BFS

```
#include<iostream>
#include <list>

using namespace std;

class Graph
{
    int V;

    list<int> *adj;
public:
    Graph(int V);

    void addEdge(int v, int w);

    void BFS(int s);
};

Graph::Graph(int V)
{
    this->V = V;
    adj = new list<int>[V];
}

void Graph::addEdge(int v, int w)
{
    adj[v].push_back(w);
}

void Graph::BFS(int s)
{
```

```
bool *visited = new bool[V];
for(int i = 0; i < V; i++)
    visited[i] = false;

list<int> queue;

visited[s] = true;
queue.push_back(s);

list<int>::iterator i;

while(!queue.empty())
{
    s = queue.front();
    cout << s << " ";
    queue.pop_front();

    for (i = adj[s].begin(); i != adj[s].end(); ++i)
    {
        if (!visited[*i])
        {
            visited[*i] = true;
            queue.push_back(*i);
        }
    }
}

int main()
{
```

```
Graph g(4);
g.addEdge(0, 1);
g.addEdge(0, 2);
g.addEdge(1, 2);
g.addEdge(2, 0);
g.addEdge(2, 3);
g.addEdge(3, 3);

cout << "Following is Breadth First Traversal "
     << "(starting from vertex 2) \n";
g.BFS(2);

return 0;
}
```

### Output:

```
E:\PRADIP\DataStructureInC++>cd "e:\PRADIP\DataStructureInC++\" && g++ BFS.cpp
-o BFS && "e:\PRADIP\DataStructureInC++\"BFS
Following is Breadth First Traversal (starting from vertex 2)
2 0 3 1
E:\PRADIP\DataStructureInC++>
```

Ln 3, Col 2   Spaces: 4   UTF-8   CRLF   C++   Win32

## DFS

```
#include <iostream>
using namespace std;

class Graph {
    int V;

    list<int>* adj;

    void DFSUtil(int v, bool visited[]);

public:
    Graph(int V);
    void addEdge(int v, int w);

    void DFS(int v);
};

Graph::Graph(int V)
{
    this->V = V;
    adj = new list<int>[V];
}

void Graph::addEdge(int v, int w)
{
    adj[v].push_back(w);
}

void Graph::DFSUtil(int v, bool visited[])
{
```

```

visited[v] = true;
cout << v << " ";

list<int>::iterator i;
for (i = adj[v].begin(); i != adj[v].end(); ++i)
    if (!visited[*i])
        DFSUtil(*i, visited);
}

void Graph::DFS(int v)
{
    bool* visited = new bool[V];
    for (int i = 0; i < V; i++)
        visited[i] = false;

    DFSUtil(v, visited);
}

int main()
{
    Graph g(4);
    g.addEdge(0, 1);
    g.addEdge(0, 2);
    g.addEdge(1, 2);
    g.addEdge(2, 0);
    g.addEdge(2, 3);
    g.addEdge(3, 3);

    cout << "Following is Depth First Traversal"
        " (starting from vertex 2) \n";
    g.DFS(2);
}

```

```
    return 0;  
}
```

### Output:

```
E:\PRADIP\DataStructureInC++>cd "e:\PRADIP\DataStructureInC++\" && g++ DFS.cpp  
-o DFS && "e:\PRADIP\DataStructureInC++\"DFS  
Following is Depth First Traversal (starting from vertex 2)  
2 0 1 3  
E:\PRADIP\DataStructureInC++>
```

Ln 6, Col 12 Spaces: 4 UTF-8 CRLF C++ Win32 ⚙️ 📁

## Kruskals

```
#include <iostream>
using namespace std;

typedef pair<int, int> iPair;

struct Graph
{
    int V, E;
    vector< pair<int, iPair> > edges;

    Graph(int V, int E)
    {
        this->V = V;
        this->E = E;
    }

    void addEdge(int u, int v, int w)
    {
        edges.push_back({w, {u, v}});
    }

    int kruskalMST();
};

struct DisjointSets
{
    int *parent, *rnk;
    int n;
```

```

DisjointSets(int n)
{
    this->n = n;
    parent = new int[n+1];
    rnk = new int[n+1];

    for (int i = 0; i <= n; i++)
    {
        rnk[i] = 0;

        parent[i] = i;
    }
}

int find(int u)
{
    if (u != parent[u])
        parent[u] = find(parent[u]);
    return parent[u];
}

void merge(int x, int y)
{
    x = find(x), y = find(y);

    if (rnk[x] > rnk[y])
        parent[y] = x;
    else
        parent[x] = y;

    if (rnk[x] == rnk[y])
        rnk[y]++;
}

```

```
        }

};

int Graph::kruskalMST()
{
    int mst_wt = 0;

    sort(edges.begin(), edges.end());

    DisjointSets ds(V);

    vector< pair<int, iPair> >::iterator it;
    for (it=edges.begin(); it!=edges.end(); it++)
    {
        int u = it->second.first;
        int v = it->second.second;

        int set_u = ds.find(u);
        int set_v = ds.find(v);

        if (set_u != set_v)
        {

            cout << u << " - " << v << endl;

            mst_wt += it->first;

            ds.merge(set_u, set_v);
        }
    }
}
```

```
    return mst_wt;
}

int main()
{
    int V = 9, E = 14;
    Graph g(V, E);

    g.addEdge(0, 1, 4);
    g.addEdge(0, 7, 8);
    g.addEdge(1, 2, 8);
    g.addEdge(1, 7, 11);
    g.addEdge(2, 3, 7);
    g.addEdge(2, 8, 2);
    g.addEdge(2, 5, 4);
    g.addEdge(3, 4, 9);
    g.addEdge(3, 5, 14);
    g.addEdge(4, 5, 10);
    g.addEdge(5, 6, 2);
    g.addEdge(6, 7, 1);
    g.addEdge(6, 8, 6);
    g.addEdge(7, 8, 7);

    cout << "Edges of MST are \n";
    int mst_wt = g.kruskalMST();

    cout << "\nWeight of MST is " << mst_wt;

    return 0;
}
```

## Output:

```
E:\PRADIP\DataStructureInC++>cd "e:\PRADIP\DataStructureInC++\" && g++ kruskal  
.c++ -o kruskal && "e:\PRADIP\DataStructureInC++\"kruskal  
Edges of MST are  
6 - 7  
2 - 8  
5 - 6  
0 - 1  
2 - 5  
2 - 3  
0 - 7  
3 - 4  
  
Weight of MST is 37  
E:\PRADIP\DataStructureInC++>
```

Ln 4, Col 1 Spaces: 4 UTF-8 CRLF C++ Win32 ⚙️ 🔔

## Prim's Algo

```
#include <bits/stdc++.h>
using namespace std;

#define V 5

int minKey(int key[], bool mstSet[])
{
    int min = INT_MAX, min_index;

    for (int v = 0; v < V; v++)
        if (mstSet[v] == false && key[v] < min)
            min = key[v], min_index = v;

    return min_index;
}

void printMST(int parent[], int graph[V][V])
{
    cout<<"Edge \tWeight\n";
    for (int i = 1; i < V; i++)
        cout<<parent[i]<< " - "<<i<< " \t"<<graph[i][parent[i]]
    ]<< " \n";
}

void primMST(int graph[V][V])
{
    int parent[V];

```

```
int key[V];  
  
bool mstSet[V];  
  
for (int i = 0; i < V; i++)  
    key[i] = INT_MAX, mstSet[i] = false;  
  
key[0] = 0;  
parent[0] = -1;  
  
for (int count = 0; count < V - 1; count++)  
{  
  
    int u = minKey(key, mstSet);  
  
    mstSet[u] = true;  
  
    for (int v = 0; v < V; v++)  
  
        if (graph[u][v] && mstSet[v] == false && graph[u][v] < key[v])  
            parent[v] = u, key[v] = graph[u][v];  
}  
  
printMST(parent, graph);  
}  
  
int main()  
{
```

```
int graph[V][V] = { { 0, 2, 0, 6, 0 },
                     { 2, 0, 3, 8, 5 },
                     { 0, 3, 0, 0, 7 },
                     { 6, 8, 0, 0, 9 },
                     { 0, 5, 7, 9, 0 } };

primMST(graph);

return 0;
}
```

## Output:

```
E:\PRADIP\DataStructureInC++>cd "e:\PRADIP\DataStructureInC++\" && g++ primsAlgo.cpp -o primsAlgo && "e:\PRADIP\DataStructureInC++\primsAlgo"
Edge    Weight
0 - 1   2
1 - 2   3
0 - 3   6
1 - 4   5
```

Ln 3, Col 2 Spaces: 4 UTF-8 CRLF C++ Win32 ⚙ ⌂