**DS FILE**

**NAME – Aryan Arora**

**ROLL NO. – 2100320120032**

**BRANCH – CS**

**SECTION - A**

**LAB - 1**

//PROGRAM FOR TRAVERSAL OF ARRAY

#include <stdio.h>

int main()

{

int a[30],n,i,j;

printf("ARYAN ARORA CS-A 2100320120032\n");

printf("ENTER THE SIZE OF THE ARRAY\n");

scanf("%d",&n);

printf("ENTER THE ELEMENTS OF THE ARRAY\n");

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

scanf("%d",&a[i]);

}

printf("ARRAY ELEMENTS ARE:\n ");

for(j=0;j<n;j++){

printf("%d ",a[j]);

}

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

ENTER THE SIZE OF THE ARRAY

5

ENTER THE ELEMENTS OF THE ARRAY

12

34

45

76

87

ARRAY ELEMENTS ARE:

12 34 45 76 87

//PROGRAM FOR INSERTING AN ELEMENT IN AN ARRAY

#include<stdio.h>

int main(){

int a[40],pos,i,size,value;

printf("ARYAN ARORA CS-A 2100320120032\n");

printf("enter no of elements in array :");

scanf("%d",&size);

printf("enter elements of the array\n");

for(i=0;i<size;i++)

scanf("%d",&a[i]);

printf("enter the position where you want to insert the element:\n");

scanf("%d",&pos);

printf("enter the value into that poition:\n");

scanf("%d",&value);

for(i=size-1;i>=pos-1;i--)

a[i+1]=a[i];

a[pos-1]= value;

printf("final array after inserting the value is\n");

for(i=0;i<=size;i++)

printf("%d\n",a[i]);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

enter no of elements in array :5

enter elements of the array

1

2

3

4

5

enter the position where you want to insert the element:

3

enter the value into that position:

8

final array after inserting the value is

1

2

8

3

4

5

// PROGRAM T0 INSERT AN ELEMENT IN AN SORTED ARRAY

#include<stdio.h>

int main( )

{

int a[20],n,item,i;

printf("ARYAN ARORA CS-A 2100320120032\N");

printf("Enter the size of the array");

scanf("%d",&n);

printf("Enter elements of the array in the sorted order");

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

scanf("%d", &a[i]);

}

printf("\nEnter ITEM to be inserted : ");

scanf("%d", &item);

i = n-1;

while(item<a[i] && i>=0) {

a[i+1] = a[i];

i--;

}

a[i+1] = item;

n++;

printf("\n\nAfter insertion array is :\n");

for(i=0; i<n; i++)

{

printf("\n%d", a[i]);

}

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Enter the size of the array

5

Enter elements of the array in the sorted order

12

13

23

45

47

Enter ITEM to be inserted :

25

After insertion array is :

12

13

23

25

45

47

// PROGRAM TO DELETE AN ELEMENT IN AN ARRAY

#include <stdio.h>

int main()

{

int array[100], position, c, n;

printf("ARYAN ARORA CS-A 2100320120032\n");

printf("Enter number of elements in array\n");

scanf("%d", &n);

printf("Enter %d elements\n", n);

for (c = 0; c < n; c++)

scanf("%d", &array[c]);

printf("Enter the location where you wish to delete element\n");

scanf("%d", &position);

if (position >= n+1)

printf("Deletion not possible.\n");

else

{

for (c = position - 1; c < n - 1; c++)

array[c] = array[c+1];

printf("Resultant array:\n");

for (c = 0; c < n - 1; c++)

printf("%d\n", array[c]);

}

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Enter number of elements in array

5

Enter 5 elements

1

2

3

4

5

Enter the location where you wish to delete element

2

Resultant array:

1

3

4

5

**LAB - 2**

// PROGRAM TO FIND THE MISSING ELEMENT IN AN ARRAY

#include <stdio.h>

void main()

{

int n, i, j, c, t, b;

printf("ARYAN ARORA CS-A 2100320120032\n");

printf("Enter size of array : \n");

scanf("%d", &n);

int array[n - 1];

printf("Enter elements into array : \n");

for (i = 0; i < n - 1; i++)

scanf("%d", &array[i]);

b = array[0];

for (i = 1; i < n - 1; i++)

b = b ^ array[i];

for (i = 2, c = 1; i <= n; i++)

c = c ^ i;

c = c ^ b;

printf("Missing element is : %d \n", c);

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Enter size of array :

5

Enter elements into array :

1

2

4

5

Missing element is : 3

//PROGRAM TO PRINT DUPLICATE ELEMENTS

#include <stdio.h>

int main()

{

int n, arr[30],I ,j;

printf("ARYAN ARORA CS-A 2100320120032\n");

printf("enter size of the array");

scanf("%d",&n);

printf("enter elements of the array");

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

scanf("%d",&arr[i]);

}

printf("Duplicate elements in given array: \n");

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

for(j = i + 1; j < n; j++) {

if(arr[i] == arr[j])

printf("%d\n", arr[j]);

}

}

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

enter size of the array8

enter elements of the array1

2

2

3

4

5

5

6

Duplicate elements in given array:

2

5

//PROGRAM TO REVERSE AN ARRAY

#include <stdio.h>

int main()

{

int n, c, d, a[100], b[100];

printf("ARYAN ARORA CS-A 2100320120032\n");

printf("Enter the number of elements in array\n");

scanf("%d", &n);

printf("Enter the array elements\n");

for (c = 0; c < n ; c++)

scanf("%d", &a[c]);

for (c = n - 1, d = 0; c >= 0; c--, d++)

b[d] = a[c];

for (c = 0; c < n; c++)

a[c] = b[c];

printf("Reverse array is\n");

for (c = 0; c < n; c++)

printf("%d\n", a[c]);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Enter the number of elements in array

5

Enter the array elements

1

2

3

4

5

Reverse array is

5

4

3

2

1

//PROGRAM TO MERGE TWO SORTED ARRAYS

#include <stdio.h>

#include <stdlib.h>

int main()

{

int i, n, j, k;

printf("ARYAN ARORA CS-A 2100320120032\n");

printf("Enter the size of the first array: ");

scanf("%d", &n);

int arr1[n];

printf("Enter the elements of the first array: \n");

for (i = 0; i < n; i++)

{

scanf("%d", &arr1[i]);

}

printf("Enter the size of the second array: ");

scanf("%d", &k);

int arr2[k];

printf("Enter the elements of the second array: \n");

for (j = 0; j < k; j++)

{

scanf("%d", &arr2[j]);

}

int arr3[n + k];

i = j = 0;

int in;

for (in = 0; in < n + k; in ++)

{

if (i < n && j < k)

{

if (arr1[i] < arr2[j])

{

arr3[in] = arr1[i];

i++;

}

else

{

arr3[in] = arr2[j];

j++;

}

}

else if (i < n)

{

arr3[in] = arr1[i];

i++;

}

else

{

arr3[in] = arr2[j];

j++;

}

}

printf("The merged array is: \n");

for (in = 0; in < n + k; in++)

{

printf("%d ", arr3[in]);

}

printf("\n");

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Enter the size of the first array: 5

Enter the elements of the first array:

1

2

3

4

5

Enter the size of the second array: 5

Enter the elements of the second array:

6

7

8

9

190

The merged array is:

1 2 3 4 5 6 7 8 9 190

**LAB - 3**

//program for matrix addition

#include<stdio.h>

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int m, n, c, d, first[10][10], second[10][10], sum[10][10];

printf("Enter the number of rows and columns of matrix\n");

scanf("%d%d", & m, & n);

printf("Enter the elements of first matrix\n");

for (c = 0; c < m; c++)

for (d = 0; d < n; d++) scanf("%d", & first[c][d]);

printf("Enter the elements of second matrix\n");

for (c = 0; c < m; c++)

for (d = 0; d < n; d++) scanf("%d", & second[c][d]);

printf("Sum of entered matrices:-\n");

for (c = 0; c < m; c++)

{

for (d = 0; d < n; d++)

{

sum[c][d] = first[c][d] + second[c][d];

printf("%d\t", sum[c][d]);

}

printf("\n");

}

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Enter the number of rows and columns of matrix

2

2

Enter the elements of first matrix

1

2

3

4

Enter the elements of second matrix

5

6

7

8

Sum of entered matrices:-

6 8

10 12

//program for matrix substraction

#include<stdio.h>

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int m, n, c, d, first[10][10], second[10][10], diff[10][10];

printf("Enter the number of rows and columns of matrix\n");

scanf("%d%d", & m, & n);

printf("Enter the elements of first matrix\n");

for (c = 0; c < m; c++)

for (d = 0; d < n; d++) scanf("%d", & first[c][d]);

printf("Enter the elements of second matrix\n");

for (c = 0; c < m; c++)

for (d = 0; d < n; d++) scanf("%d", & second[c][d]);

printf("Difference of entered matrices:-\n");

for (c = 0; c < m; c++)

{

for (d = 0; d < n; d++)

{

diff[c][d] = first[c][d] - second[c][d];

printf("%d\t", diff[c][d]);

}

printf("\n");

}

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Enter the number of rows and columns of matrix

2

2

Enter the elements of first matrix

5

6

7

8

Enter the elements of second matrix

1

2

3

4

Difference of entered matrices:-

4 4

4 4

//program for matrix multiplication

#include<stdio.h>

#include<stdlib.h>

int main(){

printf("ARYAN ARORA CS-A 2100320120032\n");

int a[10][10],b[10][10],mul[10][10],r,c,i,j,k;

printf("enter the number of row=");

scanf("%d",&r);

printf("enter the number of column=");

scanf("%d",&c);

printf("enter the first matrix element=\n");

for(i=0;i<r;i++)

{

for(j=0;j<c;j++)

{

scanf("%d",&a[i][j]);

}

}

printf("enter the second matrix element=\n");

for(i=0;i<r;i++)

{

for(j=0;j<c;j++)

{

scanf("%d",&b[i][j]);

}

}

printf("multiply of the matrix=\n");

for(i=0;i<r;i++)

{

for(j=0;j<c;j++)

{

mul[i][j]=0;

for(k=0;k<c;k++)

{

mul[i][j]+=a[i][k]\*b[k][j];

}

}

}

//for printing result

for(i=0;i<r;i++)

{

for(j=0;j<c;j++)

{

printf("%d\t",mul[i][j]);

}

printf("\n");

}

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

enter the number of row=2

enter the number of column=2

enter the first matrix element=

1

2

3

4

enter the second matrix element=

1

2

3

4

multiply of the matrix=

7 10

15 22

**LAB - 4**

//program for matrix transpose

#include<stdio.h>

int main() {

printf("ARYAN ARORA CS-A 2100320120032\n");

int a[10][10], transpose[10][10], r, c;

printf("Enter rows and columns: ");

scanf("%d %d", &r, &c);

// asssigning elements to the matrix

printf("\nEnter matrix elements:\n");

for (int i = 0; i < r; ++i)

for (int j = 0; j < c; ++j) {

printf("Enter element a%d%d: ", i + 1, j + 1);

scanf("%d", &a[i][j]);

}

// printing the matrix a[][]

printf("\nEntered matrix: \n");

for (int i = 0; i < r; ++i)

for (int j = 0; j < c; ++j) {

printf("%d ", a[i][j]);

if (j == c - 1)

printf("\n");

}

// computing the transpose

for (int i = 0; i < r; ++i)

for (int j = 0; j < c; ++j) {

transpose[j][i] = a[i][j];

}

// printing the transpose

printf("\nTranspose of the matrix:\n");

for (int i = 0; i < c; ++i)

for (int j = 0; j < r; ++j) {

printf("%d ", transpose[i][j]);

if (j == r - 1)

printf("\n");

}

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Enter rows and columns: 2

2

Enter matrix elements:

Enter element a11: 1

Enter element a12: 2

Enter element a21: 3

Enter element a22: 4

Entered matrix:

1 2

3 4

Transpose of the matrix:

1 3

2 4

//Program for matrix determinant

#include<stdio.h>

int main(){

printf("ARYAN ARORA CS-A 2100320120032\n");

int a[3][3], i, j;

long determinant;

printf("Enter the 9 elements of matrix: ");

for(i = 0 ;i < 3;i++)

for(j = 0;j < 3;j++)

scanf("%d", &a[i][j]);

printf("\nThe matrix is\n");

for(i = 0;i < 3; i++){

printf("\n");

for(j = 0;j < 3; j++)

printf("%d\t", a[i][j]);

}

determinant = a[0][0] \* ((a[1][1]\*a[2][2]) - (a[2][1]\*a[1][2])) -a[0][1] \* (a[1][0]

\* a[2][2] - a[2][0] \* a[1][2]) + a[0][2] \* (a[1][0] \* a[2][1] - a[2][0] \* a[1][1]);

printf("\nDeterminant of 3X3 matrix: %ld", determinant);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Enter the 9 elements of matrix: 1

4

2

3

4

6

5

7

6

The matrix is

1 4 2

3 4 6

5 7 6

Determinant of 3X3 matrix: 32

//program for matrix transposition without second matrix

#include<stdio.h>

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int mat[12][12];

int i,j,row,col,temp;

printf("Enter the number of rows and columns for 1st matrix\n");

scanf("%d%d",&row,&col);

printf("Enter the elements of the matrix\n");

for(i=0;i<row;i++)

{

for(j=0;j<col;j++)

{

scanf("%d",&mat[i][j]);

}

}

printf("The matrix\n");

for(i=0;i<row;i++)

{

for(j=0;j<col;j++)

{

printf("%d\t",mat[i][j]);

}

printf("\n");

}

//transpose logic using same matrix

for(i=0;i<row;i++)

{

for(j=0;j<i;j++)

{

temp=mat[i][j];

mat[i][j]=mat[j][i];

mat[j][i]=temp;

}

}

printf("The transpose of the matrix is\n");

for(i=0;i<row;i++)

{

for(j=0;j<col;j++)

{

printf("%d\t",mat[i][j]);

}

printf("\n");

}

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Enter the number of rows and columns for 1st matrix

2

2

Enter the elements of the matrix

1

2

3

4

The matrix

1 2

3 4

The transpose of the matrix is

1 3

2 4

**LAB - 5**

// PROGRAM FOR LINEAR SEARCH

#include<stdio.h>

int linear\_search(int a[],int n,int key)

{

int i,flag=0;

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

if(a[i]==key){

flag++;

break;

}

}

if(flag==1)

return i+1;

else

return -1;

}

int main()

{

int a[20],pos,i,key,n;

printf("ARYAN ARORA CS-A 2100320120032\n");

printf("enter size of the array\n");

scanf("%d",&n);

printf("enter elements of the array\n");

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

scanf("%d",&a[i]);

}

printf("enter element to find\n");

scanf("%d",&key);

pos=linear\_search(a,n,key);

if(pos==-1)

printf("element not found");

else

printf("found at %d",pos);

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

enter size of the array

5

enter elements of the array

1

2

3

4

5

enter element to find

2

found at 2

// PROGRAM FOR BINARY SEARCH

#include<stdio.h>

int binary\_search(int a[],int n,int key)

{

int low=0,high=n-1,mid;

do{

mid=(low+high)/2;

if(key==a[mid])

return mid;

else

if(key<a[mid])

high=mid-1;

else

low=mid+1;

}while(low<=high);

return -1;

}

int main()

{

int a[20],pos,i,key,n;

printf("ARYAN ARORA CS-A 2100320120032\n");

printf("enter size of the array\n");

scanf("%d",&n);

printf("enter elements of the array\n");

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

scanf("%d",&a[i]);

}

printf("enter element to find\n");

scanf("%d",&key);

pos=binary\_search(a,n,key);

if(pos==-1)

printf("element not found");

else

printf("found at %d",pos);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

enter size of the array

5

enter elements of the array

1

3

5

6

45

enter element to find

5

found at 2

// C program for Indexed Sequential Search

#include <stdio.h>

#include <stdlib.h>

void indexedSequentialSearch(int arr[], int n, int k)

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int GN = 3; // GN is group number that is number of

// elements in a group

int elements[GN], indices[GN], i, set = 0;

int j = 0, ind = 0, start, end;

for (i = 0; i < n; i += 3) {

// Storing element

elements[ind] = arr[i];

// Storing the index

indices[ind] = i;

ind++;

}

if (k < elements[0]) {

printf("Not found");

exit(0);

}

else {

for (i = 1; i <= ind; i++)

if (k <= elements[i]) {

start = indices[i - 1];

end = indices[i];

set = 1;

break;

}

}

if (set == 0) {

start = indices[GN - 1];

end = GN;

}

for (i = start; i <= end; i++) {

if (k == arr[i]) {

j = 1;

break;

}

}

if (j == 1)

printf("Found at index %d", i);

else

printf("Not found");

}

// Driver code

int main()

{

int arr[] = { 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 };

int n = sizeof(arr) / sizeof(arr[0]);

// Element to search

int k = 8;

indexedSequentialSearch(arr, n, k);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Found at index 2

**LAB – 6**

//Program for Hash Table Implementation for Basic Hash Function (Without collisions)

#include <stdio.h>

#include <string.h>

#include <stdlib.h>

#include <stdbool.h>

#define SIZE 20

struct DataItem {

int data;

int key;

};

struct DataItem\* hashArray[SIZE];

struct DataItem\* dummyItem;

struct DataItem\* item;

int hashCode(int key) {

return key % SIZE;

}

struct DataItem \*search(int key) {

//get the hash

int hashIndex = hashCode(key);

//move in array until an empty

while(hashArray[hashIndex] != NULL) {

if(hashArray[hashIndex]->key == key)

return hashArray[hashIndex];

//go to next cell

++hashIndex;

//wrap around the table

hashIndex %= SIZE;

}

return NULL;

}

void insert(int key,int data) {

struct DataItem \*item = (struct DataItem\*) malloc(sizeof(struct DataItem));

item->data = data;

item->key = key;

//get the hash

int hashIndex = hashCode(key);

//move in array until an empty or deleted cell

while(hashArray[hashIndex] != NULL && hashArray[hashIndex]->key != -1) {

//go to next cell

++hashIndex;

//wrap around the table

hashIndex %= SIZE;

}

hashArray[hashIndex] = item;

}

struct DataItem\* delete(struct DataItem\* item) {

int key = item->key;

//get the hash

int hashIndex = hashCode(key);

//move in array until an empty

while(hashArray[hashIndex] != NULL) {

if(hashArray[hashIndex]->key == key) {

struct DataItem\* temp = hashArray[hashIndex];

//assign a dummy item at deleted position

hashArray[hashIndex] = dummyItem;

return temp;

}

//go to next cell

++hashIndex;

//wrap around the table

hashIndex %= SIZE;

}

return NULL;

}

void display() {

int i = 0;

for(i = 0; i<SIZE; i++) {

if(hashArray[i] != NULL)

printf(" (%d,%d)",hashArray[i]->key,hashArray[i]->data);

else

printf(" ~~ ");

}

printf("\n");

}

int main() {

printf("ARYAN ARORA CS-A 2100320120032\n");

dummyItem = (struct DataItem\*) malloc(sizeof(struct DataItem));

dummyItem->data = -1;

dummyItem->key = -1;

insert(1, 20);

insert(2, 70);

insert(42, 80);

insert(4, 25);

insert(12, 44);

insert(14, 32);

insert(17, 11);

insert(13, 78);

insert(37, 97);

display();

item = search(37);

if(item != NULL) {

printf("Element found: %d\n", item->data);

} else {

printf("Element not found\n");

}

delete(item);

item = search(37);

if(item != NULL) {

printf("Element found: %d\n", item->data);

} else {

printf("Element not found\n");

}

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

~~ (1,20) (2,70) (42,80) (4,25) ~~ ~~ ~~ ~~ ~~ ~~ ~~ (12,44) (13,78) (14,32) ~~ ~~ (17,11) (37,97) ~~

Element found: 97

Element not found

//Program for Hash Table Implementation for Collision Resoulution using Linear Probing

#include<stdio.h>

#include<stdlib.h>

/\* to store a data (consisting of key and value) in hash table array \*/

struct item

{

int key;

int value;

};

/\* each hash table item has a flag (status) and data (consisting of key and value) \*/

struct hashtable\_item

{

int flag;

/\*

\* flag = 0 : data does not exist

\* flag = 1 : data exists

\* flag = 2 : data existed at least once

\*/

struct item \*data;

};

struct hashtable\_item \*array;

int size = 0;

int max = 10;

/\* initializing hash table array \*/

void init\_array()

{

int i;

for (i = 0; i < max; i++)

{

array[i].flag = 0;

array[i].data = NULL;

}

}

/\* to every key, it will generate a corresponding index \*/

int hashcode(int key)

{

return (key % max);

}

/\* to insert an element in the hash table \*/

void insert(int key, int value)

{

int index = hashcode(key);

int i = index;

/\* creating new item to insert in the hash table array \*/

struct item \*new\_item = (struct item\*) malloc(sizeof(struct item));

new\_item->key = key;

new\_item->value = value;

/\* probing through the array until we reach an empty space \*/

while (array[i].flag == 1)

{

if (array[i].data->key == key)

{

/\* case where already existing key matches the given key \*/

printf("\n Key already exists, hence updating its value \n");

array[i].data->value = value;

return;

}

i = (i + 1) % max;

if (i == index)

{

printf("\n Hash table is full, cannot insert any more item \n");

return;

}

}

array[i].flag = 1;

array[i].data = new\_item;

size++;

printf("\n Key (%d) has been inserted \n", key);

}

/\* to remove an element from the hash table \*/

void remove\_element(int key)

{

int index = hashcode(key);

int i = index;

/\* probing through array until we reach an empty space where not even once an element had been present \*/

while (array[i].flag != 0)

{

if (array[i].flag == 1 && array[i].data->key == key )

{

// case when data key matches the given key

array[i].flag = 2;

array[i].data = NULL;

size--;

printf("\n Key (%d) has been removed \n", key);

return;

}

i = (i + 1) % max;

if (i == index)

{

break;

}

}

printf("\n This key does not exist \n");

}

/\* to display all the elements of hash table \*/

void display()

{

int i;

for (i = 0; i < max; i++)

{

struct item \*current = (struct item\*) array[i].data;

if (current == NULL)

{

printf("\n Array[%d] has no elements \n", i);

}

else

{

printf("\n Array[%d] has elements -: \n %d (key) and %d(value) ", i, current->key, current->value);

}

}

}

int size\_of\_hashtable()

{

return size;

}

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int choice, key, value, n, c;

array = (struct hashtable\_item\*) malloc(max \* sizeof(struct hashtable\_item\*));

init\_array();

do {

printf("Implementation of Hash Table in C with Linear Probing \n\n");

printf("MENU-: \n1.Inserting item in the Hashtable"

"\n2.Removing item from the Hashtable"

"\n3.Check the size of Hashtable"

"\n4.Display Hashtable"

"\n\n Please enter your choice-:");

scanf("%d", &choice);

switch(choice)

{

case 1:

printf("Inserting element in Hashtable\n");

printf("Enter key and value-:\t");

scanf("%d %d", &key, &value);

insert(key, value);

break;

case 2:

printf("Deleting in Hashtable \n Enter the key to delete-:");

scanf("%d", &key);

remove\_element(key);

break;

case 3:

n = size\_of\_hashtable();

printf("Size of Hashtable is-:%d\n", n);

break;

case 4:

display();

break;

default:

printf("Wrong Input\n");

}

printf("\n Do you want to continue-:(press 1 for yes)\t");

scanf("%d", &c);

}while(c == 1);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Implementation of Hash Table in C with Linear Probing

MENU-:

1.Inserting item in the Hashtable

2.Removing item from the Hashtable

3.Check the size of Hashtable

4.Display Hashtable

JGFEDzDXML.o: malloc.c:2617: sysmalloc: Assertion `(old\_top == initial\_top (av) && old\_size == 0) || ((unsigned long) (old\_size) >= MINSIZE && prev\_inuse (old\_top) && ((unsigned long) old\_end & (pagesize - 1)) == 0)' failed.

Aborted

//Program for Hash Table Implementation for Collision Resoulution using Quadratic Probing

#include<stdio.h>

#include<stdlib.h>

/\* to store a data (consisting of key and value) in hash table array \*/

struct item

{

int key;

int value;

};

/\* each hash table item has a flag (status) and data (consisting of key and value) \*/

struct hashtable\_item

{

int flag;

/\*

\* flag = 0 : data does not exist

\* flag = 1 : data exists at given array location

\* flag = 2 : data was present at least once

\*/

struct item \*data;

};

struct hashtable\_item \*array;

int size = 0;

int max = 10;

/\* this function returns corresponding index of the given key \*/

int hashcode(int key)

{

return (key % max);

}

/\* this function initializes the hash table array \*/

void init\_array()

{

int i;

for (i = 0; i < max; i++)

{

array[i].flag = 0;

array[i].data = NULL;

}

}

/\* this function inserts an element in the hash table \*/

void insert(int key, int value)

{

int index = hashcode(key);

int i = index;

int h = 1;

struct item \*new\_item = (struct item\*) malloc(sizeof(struct item));

new\_item->key = key;

new\_item->value = value;

/\* probing through the array until an empty space is found \*/

while (array[i].flag == 1)

{

if (array[i].data->key == key)

{

/\* case when already present key matches the given key \*/

printf("\n This key is already present in hash table, hence updating it's value \n");

array[i].data->value = value;

return;

}

i = (i + (h \* h)) % max;

h++;

if (i == index)

{

printf("\n Hash table is full, cannot add more elements \n");

return;

}

}

array[i].flag = 1;

array[i].data = new\_item;

printf("\n Key (%d) has been inserted\n", key);

size++;

}

/\* to remove an element form the hash table array \*/

void remove\_element(int key)

{

int index = hashcode(key);

int i = index;

int h = 1;

/\* probing through the hash table until we reach at location where there had not been an element even once \*/

while (array[i].flag != 0)

{

if (array[i].flag == 1 && array[i].data->key == key)

{

/\* case where data exists at the location and its key matches to the given key \*/

array[i].flag = 2;

array[i].data = NULL;

size--;

printf("\n Key (%d) has been removed \n", key);

return;

}

i = (i + (h \* h)) % max;

h++;

if (i == index)

{

break;

}

}

printf("\n Key does not exist \n");

}

/\* to display the contents of hash table \*/

void display()

{

int i;

for(i = 0; i < max; i++)

{

if (array[i].flag != 1)

{

printf("\n Array[%d] has no elements \n", i);

}

else

{

printf("\n Array[%d] has elements \n %d (key) and %d (value) \n", i, array[i].data->key, array[i].data->value);

}

}

}

int size\_of\_hashtable()

{

return size;

}

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int choice, key, value, n, c;

array = (struct hashtable\_item\*) malloc(max \* sizeof(struct hashtable\_item\*));

init\_array();

do {

printf("Implementation of Hash Table in C with Quadratic Probing.\n\n");

printf("MENU-: \n1.Inserting item in the Hash table"

"\n2.Removing item from the Hash table"

"\n3.Check the size of Hash table"

"\n4.Display Hash table"

"\n\n Please enter your choice-:");

scanf("%d", &choice);

switch(choice)

{

case 1:

printf("Inserting element in Hash table \n");

printf("Enter key and value-:\t");

scanf("%d %d", &key, &value);

insert(key, value);

break;

case 2:

printf("Deleting in Hash table \n Enter the key to delete-:");

scanf("%d", &key);

remove\_element(key);

break;

case 3:

n = size\_of\_hashtable();

printf("Size of Hash table is-:%d\n", n);

break;

case 4:

display();

break;

default:

printf("Wrong Input\n");

}

printf("\n Do you want to continue-:(press 1 for yes)\t");

scanf("%d", &c);

}while(c == 1);

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Implementation of Hash Table in C with Quadratic Probing.

MENU-:

1.Inserting item in the Hash table

2.Removing item from the Hash table

3.Check the size of Hash table

4.Display Hash table

Please enter your choice-:3

Size of Hash table is-:0

Do you want to continue-:(press 1 for yes) 1

Implementation of Hash Table in C with Quadratic Probing.

MENU-:

1.Inserting item in the Hash table

2.Removing item from the Hash table

3.Check the size of Hash table

4.Display Hash table

Please enter your choice-:4

Array[0] has no elements

Array[1] has no elements

Array[2] has no elements

Array[3] has no elements

Array[4] has no elements

Array[5] has no elements

Array[6] has no elements

Array[7] has no elements

Array[8] has no elements

Array[9] has no elements

Do you want to continue-:(press 1 for yes)

//Program for Hash Table Implementation for Collision Resoulution using Double Hashing/Re-Hashing

#include<stdio.h>

#include<math.h>

struct data

{

int key;

int value;

};

struct hashtable\_item

{

int flag;

/\*

\* flag = 0 : data not present

\* flag = 1 : some data already present

\* flag = 2 : data was present,but deleted

\*/

struct data \*item;

};

struct hashtable\_item \*array;

int max = 7;

int size = 0;

int prime = 3;

int hashcode1(int key)

{

return (key % max);

}

int hashcode2(int key)

{

return (prime - (key % prime));

}

void insert(int key, int value)

{

int hash1 = hashcode1(key);

int hash2 = hashcode2(key);

int index = hash1;

/\* create new data to insert \*/

struct data \*new\_item = (struct data\*) malloc(sizeof(struct data));

new\_item->key = key;

new\_item->value = value;

if (size == max)

{

printf("\n Hash Table is full, cannot insert more items \n");

return;

}

/\* probing through other array elements \*/

while (array[index].flag == 1) {

if (array[index].item->key == key)

{

printf("\n Key already present, hence updating its value \n");

array[index].item->value = value;

return;

}

index = (index + hash2) % max;

if (index == hash1)

{

printf("\n Add is failed \n");

return;

}

printf("\n probing \n");

}

array[index].item = new\_item;

array[index].flag = 1;

size++;

printf("\n Key (%d) has been inserted \n", key);

}

/\* to remove an element from the array \*/

void remove\_element(int key)

{

int hash1 = hashcode1(key);

int hash2 = hashcode2(key);

int index = hash1;

if (size == 0)

{

printf("\n Hash Table is empty \n");

return;

}

/\* probing through other elements \*/

while (array[index].flag != 0)

{

if (array[index].flag == 1 && array[index].item->key == key)

{

array[index].item = NULL;

array[index].flag = 2;

size--;

printf("\n Key (%d) has been removed \n", key);

return;

}

index = (index + hash2) % max;

if (index == hash1)

{

break;

}

}

printf("\n Key (%d) does not exist \n", key);

}

int size\_of\_hashtable()

{

return size;

}

/\* displays all elements of array \*/

void display()

{

int i;

for (i = 0; i < max; i++)

{

if (array[i].flag != 1)

{

printf("\n Array[%d] has no elements \n", i);

}

else

{

printf("\n Array[%d] has elements \n Key (%d) and Value (%d) \n", i, array[i].item->key, array[i].item->value);

}

}

}

/\* initializes array \*/

void init\_array()

{

int i;

for(i = 0; i < max; i++)

{

array[i].item = NULL;

array[i].flag = 0;

}

prime = get\_prime();

}

/\* returns largest prime number less than size of array \*/

int get\_prime()

{

int i,j;

for (i = max - 1; i >= 1; i--)

{

int flag = 0;

for (j = 2; j <= (int)sqrt(i); j++)

{

if (i % j == 0)

{

flag++;

}

}

if (flag == 0)

{

return i;

}

}

return 3;

}

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int choice, key, value, n, c;

array = (struct hashtable\_item\*) malloc(max \* sizeof(struct hashtable\_item));

init\_array();

do {

printf("Implementation of Hash Table in C with Double Hashing.\n\n");

printf("MENU-: \n1.Inserting item in the Hash Table"

"\n2.Removing item from the Hash Table"

"\n3.Check the size of Hash Table"

"\n4.Display Hash Table"

"\n\n Please enter your choice-:");

scanf("%d", &choice);

switch(choice)

{

case 1:

printf("Inserting element in Hash Table\n");

printf("Enter key and value-:\t");

scanf("%d %d", &key, &value);

insert(key, value);

break;

case 2:

printf("Deleting in Hash Table \n Enter the key to delete-:");

scanf("%d", &key);

remove\_element(key);

break;

case 3:

n = size\_of\_hashtable();

printf("Size of Hash Table is-:%d\n", n);

break;

case 4:

display();

break;

default:

printf("Wrong Input\n");

}

printf("\n Do you want to continue-:(press 1 for yes)\t");

scanf("%d", &c);

}while(c == 1);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Implementation of Hash Table in C with Double Hashing.

MENU-:

1.Inserting item in the Hash Table

2.Removing item from the Hash Table

3.Check the size of Hash Table

4.Display Hash Table

Please enter your choice-:1

Inserting element in Hash Table

Enter key and value-: 2

4

Key (2) has been inserted

Do you want to continue-:(press 1 for yes) 1

Implementation of Hash Table in C with Double Hashing.

MENU-:

1.Inserting item in the Hash Table

2.Removing item from the Hash Table

3.Check the size of Hash Table

4.Display Hash Table

Please enter your choice-:1

Inserting element in Hash Table

Enter key and value-: 4

6

Key (4) has been inserted

Do you want to continue-:(press 1 for yes) 1

Implementation of Hash Table in C with Double Hashing.

MENU-:

1.Inserting item in the Hash Table

2.Removing item from the Hash Table

3.Check the size of Hash Table

4.Display Hash Table

Please enter your choice-:3

Size of Hash Table is-:2

Do you want to continue-:(press 1 for yes) 1

Implementation of Hash Table in C with Double Hashing.

MENU-:

1.Inserting item in the Hash Table

2.Removing item from the Hash Table

3.Check the size of Hash Table

4.Display Hash Table

Please enter your choice-:4

Array[0] has no elements

Array[1] has no elements

Array[2] has elements

Key (2) and Value (4)

Array[3] has no elements

Array[4] has elements

Key (4) and Value (6)

Array[5] has no elements

Array[6] has no elements

Do you want to continue-:(press 1 for yes)

**LAB – 7**

//Program to print factorial of a number using recursion

#include<stdio.h>

long int multiplyNumbers(int n);

int main() {

printf("ARYAN ARORA CS-A 2100320120032\n");

int n;

printf("Enter a positive integer: ");

scanf("%d",&n);

printf("Factorial of %d = %ld", n, multiplyNumbers(n));

return 0;

}

long int multiplyNumbers(int n) {

if (n>=1)

return n\*multiplyNumbers(n-1);

else

return 1;

}

**OUTPUT:**

ARYAN ARORA CS-A 2100320120032

Enter a positive integer: 5

Factorial of 5 = 120

// Program for Computing A raised to power n using Recursion

#include <stdio.h>

int power(int n1, int n2);

int main() {

printf("ARYAN ARORA CS-A 2100320120032\n");

int base, a, result;

printf("Enter base number: ");

scanf("%d", &base);

printf("Enter power number(positive integer): ");

scanf("%d", &a);

result = power(base, a);

printf("%d^%d = %d", base, a, result);

return 0;

}

int power(int base, int a) {

if (a != 0)

return (base \* power(base, a - 1));

else

return 1;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Enter base number: 6

Enter power number(positive integer): 3

6^3 = 216

//Program for finding nth Fibonacci number using Recursion and improving its run time to save stack operations

#include <stdio.h>

int fibo(int);

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int num;

int result;

printf("Enter the nth number in fibonacci series: ");

scanf("%d", &num);

if (num < 0)

{

printf("Fibonacci of negative number is not possible.\n");

}

else

{

result = fibo(num);

printf("The %d number in fibonacci series is %d\n", num, result);

}

return 0;

}

int fibo(int num)

{

if (num == 0)

{

return 0;

}

else if (num == 1)

{

return 1;

}

else

{

return(fibo(num - 1) + fibo(num - 2));

}

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Enter the nth number in fibonacci series: 5

The 5 number in fibonacci series is 5

// Program for finding GCD of two numbers using Recursion

#include <stdio.h>

#include <conio.h>

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

// declare the variables

int n1, n2, i, GCD\_Num;

printf ( " Enter any two numbers: \n ");

scanf ( "%d %d", &n1, &n2);

// use for loop

for( i = 1; i <= n1 && i <= n2; ++i)

{

if (n1 % i ==0 && n2 % i == 0)

GCD\_Num = i; /\* if n1 and n2 is completely divisible by i, the divisible number will be the GCD\_Num \*/

}

// print the GCD of two numbers

printf (" GCD of two numbers %d and %d is %d.", n1, n2, GCD\_Num);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Enter any two numbers:

21

25

GCD of two numbers 21 and 25 is 1.

// Binary Search with Recursion

#include <stdio.h>

int iterativeBinarySearch(int array[], int start\_index, int end\_index, int element){

while (start\_index <= end\_index){

int middle = start\_index + (end\_index- start\_index )/2;

if (array[middle] == element)

return middle;

if (array[middle] < element)

start\_index = middle + 1;

else

end\_index = middle - 1;

}

return -1;

}

int main(void){

printf("ARYAN ARORA CS-A 2100320120032\n");

int array[] = {1, 4, 7, 9, 16, 56, 70};

int n = 7;

int element = 16;

int found\_index = iterativeBinarySearch(array, 0, n-1, element);

if(found\_index == -1 ) {

printf("Element not found in the array ");

}

else {

printf("Element found at index : %d",found\_index);

}

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Element found at index : 4

**LAB – 8**

// Program for Towers of Hanoi for n disk (user defined)

#include <stdio.h>

// C recursive function to solve tower of hanoi puzzle

void towerOfHanoi(int n, char from\_rod, char to\_rod, char aux\_rod)

{

if (n == 1)

{

printf("\n Move disk 1 from rod %c to rod %c", from\_rod, to\_rod);

return;

}

towerOfHanoi(n-1, from\_rod, aux\_rod, to\_rod);

printf("\n Move disk %d from rod %c to rod %c", n, from\_rod, to\_rod);

towerOfHanoi(n-1, aux\_rod, to\_rod, from\_rod);

}

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int n = 4; // Number of disks

towerOfHanoi(n, 'A', 'C', 'B'); // A, B and C are names of rods

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Move disk 1 from rod A to rod B

Move disk 2 from rod A to rod C

Move disk 1 from rod B to rod C

Move disk 3 from rod A to rod B

Move disk 1 from rod C to rod A

Move disk 2 from rod C to rod B

Move disk 1 from rod A to rod B

Move disk 4 from rod A to rod C

Move disk 1 from rod B to rod C

Move disk 2 from rod B to rod A

Move disk 1 from rod C to rod A

Move disk 3 from rod B to rod C

Move disk 1 from rod A to rod B

Move disk 2 from rod A to rod C

Move disk 1 from rod B to rod C

// Program to reverse the given number using Recursion

#include<stdio.h>

main ( ){

printf("ARYAN ARORA CS-A 2100320120032\n");

int n,f;

int fact (int);

clrscr ( );

printf ("enter a number");

scanf ("%d", &n);

f= fact (n);

printf (factorial value = %d",f);

}

int fact (int n){

int f;

if ( ( n==1) || (n==0))

return 1;

else

f= n\*fact (n-1);

return f;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Enter any number:34

The reverse of entered number is :43

// Finding sum of the digits of the number

#include<stdio.h>

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int n,sum=0,m;

printf("Enter a number:");

scanf("%d",&n);

while(n>0)

{

m=n%10;

sum=sum+m;

n=n/10;

}

printf("Sum is=%d",sum);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Enter a number:234

Sum is=9

// To check if the given string is a palindrome using Recursion

#include <stdio.h>

#include <string.h>

#include <stdbool.h>

// A recursive function that

// check a str[s..e] is

// palindrome or not.

bool isPalRec(char str[],

int s, int e)

{

// If there is only one character

if (s == e)

return true;

// If first and last

// characters do not match

if (str[s] != str[e])

return false;

// If there are more than

// two characters, check if

// middle substring is also

// palindrome or not.

if (s < e + 1)

return isPalRec(str, s + 1, e - 1);

return true;

}

bool isPalindrome(char str[])

{

int n = strlen(str);

// An empty string is

// considered as palindrome

if (n == 0)

return true;

return isPalRec(str, 0, n - 1);

}

// Driver Code

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

char str[] = "geeg";

if (isPalindrome(str))

printf("Yes");

else

printf("No");

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Yes

**LAB – 9**

// Program for Bubble Sort

#include <stdio.h>

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int array[100], n, c, d, swap;

printf("Enter number of elements\n");

scanf("%d", &n);

printf("Enter %d integers\n", n);

for (c = 0; c < n; c++)

scanf("%d", &array[c]);

for (c = 0 ; c < n - 1; c++)

{

for (d = 0 ; d < n - c - 1; d++)

{

if (array[d] > array[d+1]) /\* For decreasing order use '<' instead of '>' \*/

{

swap = array[d];

array[d] = array[d+1];

array[d+1] = swap;

}

}

}

printf("Sorted list in ascending order:\n");

for (c = 0; c < n; c++)

printf("%d\n", array[c]);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Enter number of elements

5

Enter 5 integers

2

4

1

7

3

Sorted list in ascending order:

1

2

3

4

7

// Program for Selection Sort

#include <stdio.h>

void selection(int arr[], int n)

{

int i, j, small;

for (i = 0; i < n-1; i++) // One by one move boundary of unsorted subarray

{

small = i; //minimum element in unsorted array

for (j = i+1; j < n; j++)

if (arr[j] < arr[small])

small = j;

// Swap the minimum element with the first element

int temp = arr[small];

arr[small] = arr[i];

arr[i] = temp;

}

}

void printArr(int a[], int n) /\* function to print the array \*/

{

int i;

for (i = 0; i < n; i++)

printf("%d ", a[i]);

}

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int a[] = { 12, 31, 25, 8, 32, 17 };

int n = sizeof(a) / sizeof(a[0]);

printf("Before sorting array elements are - \n");

printArr(a, n);

selection(a, n);

printf("\nAfter sorting array elements are - \n");

printArr(a, n);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Before sorting array elements are -

12 31 25 8 32 17

After sorting array elements are -

8 12 17 25 31 32

// Program for Insertion Sort

#include <stdio.h>

void insert(int a[], int n) /\* function to sort an aay with insertion sort \*/

{

int i, j, temp;

for (i = 1; i < n; i++) {

temp = a[i];

j = i - 1;

while(j>=0 && temp <= a[j]) /\* Move the elements greater than temp to one position ahead from their current position\*/

{

a[j+1] = a[j];

j = j-1;

}

a[j+1] = temp;

}

}

void printArr(int a[], int n) /\* function to print the array \*/

{

int i;

for (i = 0; i < n; i++)

printf("%d ", a[i]);

}

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int a[] = { 12, 31, 25, 8, 32, 17 };

int n = sizeof(a) / sizeof(a[0]);

printf("Before sorting array elements are - \n");

printArr(a, n);

insert(a, n);

printf("\nAfter sorting array elements are - \n");

printArr(a, n);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Before sorting array elements are -

12 31 25 8 32 17

After sorting array elements are -

8 12 17 25 31 32

// Program for Implementation of Shell Sort

#include <stdio.h>

/\* function to implement shellSort \*/

int shell(int a[], int n)

{

/\* Rearrange the array elements at n/2, n/4, ..., 1 intervals \*/

for (int interval = n/2; interval > 0; interval /= 2)

{

for (int i = interval; i < n; i += 1)

{

/\* store a[i] to the variable temp and make the ith position empty \*/

int temp = a[i];

int j;

for (j = i; j >= interval && a[j - interval] > temp; j -= interval)

a[j] = a[j - interval];

// put temp (the original a[i]) in its correct position

a[j] = temp;

}

}

return 0;

}

void printArr(int a[], int n) /\* function to print the array elements \*/

{

int i;

for (i = 0; i < n; i++)

printf("%d ", a[i]);

}

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int a[] = { 33, 31, 40, 8, 12, 17, 25, 42 };

int n = sizeof(a) / sizeof(a[0]);

printf("Before sorting array elements are - \n");

printArr(a, n);

shell(a, n);

printf("\nAfter applying shell sort, the array elements are - \n");

printArr(a, n);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Before sorting array elements are -

33 31 40 8 12 17 25 42

After applying shell sort, the array elements are -

8 12 17 25 31 33 40 42

**LAB – 10**

// Program for Merge Sort

// C program for Merge Sort

#include <stdio.h>

#include <stdlib.h>

// Merges two subarrays of arr[].

// First subarray is arr[l..m]

// Second subarray is arr[m+1..r]

void merge(int arr[], int l,

int m, int r)

{

int i, j, k;

int n1 = m - l + 1;

int n2 = r - m;

// Create temp arrays

int L[n1], R[n2];

// Copy data to temp arrays

// L[] and R[]

for (i = 0; i < n1; i++)

L[i] = arr[l + i];

for (j = 0; j < n2; j++)

R[j] = arr[m + 1 + j];

// Merge the temp arrays back

// into arr[l..r]

// Initial index of first subarray

i = 0;

// Initial index of second subarray

j = 0;

// Initial index of merged subarray

k = l;

while (i < n1 && j < n2)

{

if (L[i] <= R[j])

{

arr[k] = L[i];

i++;

}

else

{

arr[k] = R[j];

j++;

}

k++;

}

// Copy the remaining elements

// of L[], if there are any

while (i < n1) {

arr[k] = L[i];

i++;

k++;

}

// Copy the remaining elements of

// R[], if there are any

while (j < n2)

{

arr[k] = R[j];

j++;

k++;

}

}

// l is for left index and r is

// right index of the sub-array

// of arr to be sorted

void mergeSort(int arr[],

int l, int r)

{

if (l < r)

{

// Same as (l+r)/2, but avoids

// overflow for large l and h

int m = l + (r - l) / 2;

// Sort first and second halves

mergeSort(arr, l, m);

mergeSort(arr, m + 1, r);

merge(arr, l, m, r);

}

}

// UTILITY FUNCTIONS

// Function to print an array

void printArray(int A[], int size)

{

int i;

for (i = 0; i < size; i++)

printf("%d ", A[i]);

printf("\n");

}

// Driver code

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int arr[] = {12, 11, 13, 5, 6, 7};

int arr\_size = sizeof(arr) / sizeof(arr[0]);

printf("Given array is \n");

printArray(arr, arr\_size);

mergeSort(arr, 0, arr\_size - 1);

printf("\nSorted array is \n");

printArray(arr, arr\_size);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Given array is

12 11 13 5 6 7

Sorted array is

5 6 7 11 12 13

// Program for Quick Sort

#include <stdio.h>

// function to swap elements

void swap(int \*a, int \*b) {

int t = \*a;

\*a = \*b;

\*b = t;

}

// function to find the partition position

int partition(int array[], int low, int high) {

// select the rightmost element as pivot

int pivot = array[high];

// pointer for greater element

int i = (low - 1);

// traverse each element of the array

// compare them with the pivot

for (int j = low; j < high; j++) {

if (array[j] <= pivot) {

// if element smaller than pivot is found

// swap it with the greater element pointed by i

i++;

// swap element at i with element at j

swap(&array[i], &array[j]);

}

}

// swap the pivot element with the greater element at i

swap(&array[i + 1], &array[high]);

// return the partition point

return (i + 1);

}

void quickSort(int array[], int low, int high) {

if (low < high) {

// find the pivot element such that

// elements smaller than pivot are on left of pivot

// elements greater than pivot are on right of pivot

int pi = partition(array, low, high);

// recursive call on the left of pivot

quickSort(array, low, pi - 1);

// recursive call on the right of pivot

quickSort(array, pi + 1, high);

}

}

// function to print array elements

void printArray(int array[], int size) {

for (int i = 0; i < size; ++i) {

printf("%d ", array[i]);

}

printf("\n");

}

// main function

int main() {

printf("ARYAN ARORA CS-A 2100320120032\n");

int data[] = {8, 7, 2, 1, 0, 9, 6};

int n = sizeof(data) / sizeof(data[0]);

printf("Unsorted Array\n");

printArray(data, n);

// perform quicksort on data

quickSort(data, 0, n - 1);

printf("Sorted array in ascending order: \n");

printArray(data, n);

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Unsorted Array

8 7 2 1 0 9 6

Sorted array in ascending order:

0 1 2 6 7 8 9

**LAB – 11**

// Program for Randomized Quick Sort

# include <stdio.h>

#include <stdlib.h>

#include <time.h>

int getBig(int \*a, int i, int right, int pivot)

{

for (int k = i; k <= right; k++)

{

if (a[k] > pivot)

return k;

}

return right + 1;

}

int getSmall(int \*a, int j, int left, int pivot)

{

for (int k = j; k >= left; k--)

{

if (a[k] < pivot)

return k;

}

return -1;

}

void swap(int \*a, int \*b)

{

int t = \*a;

\*a = \*b;

\*b = t;

}

void random\_quick(int \*a, int left, int right)

{

if (left >= right)

return;

int index = left + (rand() % (right - left)), i = left, j = right;

int pivot\_index = index;

int pivot = a[index];

// storing index of element greater than pivot

i = getBig(a, i, right, pivot);

// storing index of element smaller than pivot

j = getSmall(a, j, left, pivot);

while (i <= j)

{

swap(&a[i], &a[j]);

i = getBig(a, i, right, pivot);

j = getSmall(a, j, left, pivot);

}

// after separating the smaller and greater elements, there are 3 cases

// possible

if (pivot\_index > j && pivot\_index > i)

{

// case 1. When the pivot element index is greater than both i and j

swap(&a[i], &a[pivot\_index]);

random\_quick(a, left, i - 1);

random\_quick(a, i + 1, right);

}

else if (pivot\_index < j && pivot\_index < i)

{

// case 2. When the pivot element index is smaller than both i and j

swap(&a[j], &a[pivot\_index]);

random\_quick(a, left, j - 1);

random\_quick(a, j + 1, right);

}

else

{

// the pivot element is at its origin position.

random\_quick(a, left, pivot\_index - 1);

random\_quick(a, pivot\_index + 1, right);

}

}

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

srand(time(0));

int num;

printf("Input number of elements you want to sort: ");

scanf("%d", &num);

printf("\nInput the numbers:\n");

int \*arr = (int \*)malloc(num \* sizeof(int));

for (int i = 0; i < num; i++)

{

scanf("%d", &arr[i]);

}

random\_quick(arr, 0, num - 1);

printf("\nSorted array: ");

for (int i = 0; i < num; i++)

{

printf("%d ", arr[i]);

}

free(arr);

printf("\n");

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Input number of elements you want to sort: 5

Input the numbers:

23

12

67

54

43

Sorted array: 12 23 43 54 67

// Program for Counting Sort

#include<stdio.h>

int getMax(int a[], int n) {

int max = a[0];

for(int i = 1; i<n; i++) {

if(a[i] > max)

max = a[i];

}

return max; //maximum element from the array

}

void countSort(int a[], int n) // function to perform counting sort

{

int output[n+1];

int max = getMax(a, n);

int count[max+1]; //create count array with size [max+1]

for (int i = 0; i <= max; ++i)

{

count[i] = 0; // Initialize count array with all zeros

}

for (int i = 0; i < n; i++) // Store the count of each element

{

count[a[i]]++;

}

for(int i = 1; i<=max; i++)

count[i] += count[i-1]; //find cumulative frequency

/\* This loop will find the index of each element of the original array in count array, and

place the elements in output array\*/

for (int i = n - 1; i >= 0; i--) {

output[count[a[i]] - 1] = a[i];

count[a[i]]--; // decrease count for same numbers

}

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

a[i] = output[i]; //store the sorted elements into main array

}

}

void printArr(int a[], int n) /\* function to print the array \*/

{

int i;

for (i = 0; i < n; i++)

printf("%d ", a[i]);

}

int main() {

printf("ARYAN ARORA CS-A 2100320120032\n");

int a[] = { 11, 30, 24, 7, 31, 16 };

int n = sizeof(a)/sizeof(a[0]);

printf("Before sorting array elements are - \n");

printArr(a, n);

countSort(a, n);

printf("\nAfter sorting array elements are - \n");

printArr(a, n);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Before sorting array elements are -

11 30 24 7 31 16

After sorting array elements are -

7 11 16 24 30 31

// Program for Radix Sort

#include <stdio.h>

// function to get maximum element from array

int find\_max(int arr[], int n) {

int max\_element = arr[0];

for(int i = 1; i<n; i++) {

if(arr[i] > max\_element)

max\_element = arr[i];

}

return max\_element;

}

void countingSort(int arr[], int n, int pos)

{

int result[n + 1];

int count[10] = {0};

// count howmany numbers are present with digit 0-9 at given position

for (int i = 0; i < n; i++)

count[(arr[i] / pos) % 10]++;

// now do prefix sum of the count array

for (int i = 1; i < 10; i++)

count[i] += count[i - 1];

// Place the elements in sorted order

for (int i = n - 1; i >= 0; i--) {

result[count[(arr[i] / pos) % 10] - 1] = arr[i];

count[(arr[i] / pos) % 10]--;

}

for (int i = 0; i < n; i++)

arr[i] = result[i];

}

void radixsort(int arr[], int n) {

int max\_element = find\_max(arr, n);

// counting sort from the least significant digit to the most significant digit

for (int pos = 1; max\_element / pos > 0; pos \*= 10)

countingSort(arr, n, pos);

}

int main() {

printf("ARYAN ARORA CS-A 2100320120032\n");

int arr[] = {312, 42, 635, 11, 8, 783, 954, 777};

int n = sizeof(arr) / sizeof(arr[0]);

printf("An array before applying the radix sort: \n");

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

printf("%d ", arr[i]);

}

printf("\n");

radixsort(arr, n);

printf("An array after applying the radix sort: \n");

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

printf("%d ", arr[i]);

}

printf("\n");

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

An array before applying the radix sort:

312 42 635 11 8 783 954 777

An array after applying the radix sort:

8 11 42 312 635 777 783 954

**LAB – 12**

// Program for Stack Primitive Operations

#include <stdio.h>

int stack[100],i,j,choice=0,n,top=-1;

void push();

void pop();

void show();

int main ()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

printf("Enter the number of elements in the stack ");

scanf("%d",&n);

printf("\*\*\*\*\*\*\*\*\*Stack operations using array\*\*\*\*\*\*\*\*\*");

printf("\n----------------------------------------------\n");

while(choice != 4)

{

printf("Chose one from the below options...\n");

printf("\n1.Push\n2.Pop\n3.Show\n4.Exit");

printf("\n Enter your choice \n");

scanf("%d",&choice);

switch(choice)

{

case 1:

{

push();

break;

}

case 2:

{

pop();

break;

}

case 3:

{

show();

break;

}

case 4:

{

printf("Exiting....");

break;

}

default:

{

printf("Please Enter valid choice ");

}

};

}

return 0;

}

void push ()

{

int val;

if (top == n )

printf("\n Overflow");

else

{

printf("Enter the value?");

scanf("%d",&val);

top = top +1;

stack[top] = val;

}

}

void pop ()

{

if(top == -1)

printf("Underflow");

else

top = top -1;

}

void show()

{

for (i=top;i>=0;i--)

{

printf("%d\n",stack[i]);

}

if(top == -1)

{

printf("Stack is empty");

}

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Enter the number of elements in the stack 3

\*\*\*\*\*\*\*\*\*Stack operations using array\*\*\*\*\*\*\*\*\*

----------------------------------------------

Chose one from the below options...

1.Push

2.Pop

3.Show

4.Exit

Enter your choice

1

Enter the value?3

Chose one from the below options...

1.Push

2.Pop

3.Show

4.Exit

Enter your choice

1

Enter the value?4

Chose one from the below options...

1.Push

2.Pop

3.Show

4.Exit

Enter your choice

1

Enter the value?5

Chose one from the below options...

1.Push

2.Pop

3.Show

4.Exit

Enter your choice

2

Chose one from the below options...

1.Push

2.Pop

3.Show

4.Exit

Enter your choice

3

4

3

Chose one from the below options...

1.Push

2.Pop

3.Show

4.Exit

Enter your choice

3

4

3

Chose one from the below options...

1.Push

2.Pop

3.Show

4.Exit

Enter your choice

3

4

3

Chose one from the below options...

1.Push

2.Pop

3.Show

4.Exit

Enter your choice

1

Enter the value?6

Chose one from the below options...

1.Push

2.Pop

3.Show

4.Exit

Enter your choice

3

6

4

3

Chose one from the below options...

1.Push

2.Pop

3.Show

4.Exit

Enter your choice

4

Exiting....

// Program for Decimal to Any Base Conversion

#include<stdio.h>

#include<stdlib.h>

int main(){

printf("ARYAN ARORA CS-A 2100320120032\n");

int a[10],n,i;

system ("cls");

printf("Enter the number to convert: ");

scanf("%d",&n);

for(i=0;n>0;i++)

{

a[i]=n%2;

n=n/2;

}

printf("\nBinary of Given Number is=");

for(i=i-1;i>=0;i--)

{

printf("%d",a[i]);

}

return 0;

}

OUTPUT:

Enter the number to convert: 34

Binary of Given Number is=100010

// Program to check the validity of Parenthesized Arithmetic Expression using Stack

#include <stdio.h>

#include <stdlib.h>

#include <string.h>

int top = -1;

char stack[100];

// function prototypes

void push(char);

void pop();

void find\_top();

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int i;

char a[100];

printf("enter expression\n");

scanf("%s", &a);

for (i = 0; a[i] != '\0';i++)

{

if (a[i] == '(')

{

push(a[i]);

}

else if (a[i] == ')')

{

pop();

}

}

find\_top();

return 0;

}

// to push elements in stack

void push(char a)

{

stack[top] = a;

top++;

}

// to pop elements from stack

void pop()

{

if (top == -1)

{

printf("expression is invalid\n");

exit(0);

}

else

{

top--;

}

}

// to find top element of stack

void find\_top()

{

if (top == -1)

printf("\nexpression is valid\n");

else

printf("\nexpression is invalid\n");

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

enter expression

hello world

expression is valid

**LAB - 13**

// Program to check the validity of Bracketed Arithmetic Expression using Stack

#include <stdio.h>

#include <stdlib.h>

#define bool int

// structure of a stack node

struct sNode {

char data;

struct sNode\* next;

};

// Function to push an item to stack

void push(struct sNode\*\* top\_ref, int new\_data);

// Function to pop an item from stack

int pop(struct sNode\*\* top\_ref);

// Returns 1 if character1 and character2 are matching left

// and right Brackets

bool isMatchingPair(char character1, char character2)

{

if (character1 == '(' && character2 == ')')

return 1;

else if (character1 == '{' && character2 == '}')

return 1;

else if (character1 == '[' && character2 == ']')

return 1;

else

return 0;

}

// Return 1 if expression has balanced Brackets

bool areBracketsBalanced(char exp[])

{

int i = 0;

// Declare an empty character stack

struct sNode\* stack = NULL;

// Traverse the given expression to check matching

// brackets

while (exp[i])

{

// If the exp[i] is a starting bracket then push

// it

if (exp[i] == '{' || exp[i] == '(' || exp[i] == '[')

push(&stack, exp[i]);

// If exp[i] is an ending bracket then pop from

// stack and check if the popped bracket is a

// matching pair\*/

if (exp[i] == '}' || exp[i] == ')'

|| exp[i] == ']') {

// If we see an ending bracket without a pair

// then return false

if (stack == NULL)

return 0;

// Pop the top element from stack, if it is not

// a pair bracket of character then there is a

// mismatch.

// his happens for expressions like {(})

else if (!isMatchingPair(pop(&stack), exp[i]))

return 0;

}

i++;

}

// If there is something left in expression then there

// is a starting bracket without a closing

// bracket

if (stack == NULL)

return 1; // balanced

else

return 0; // not balanced

}

// Driver code

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

char exp[100] = "{()}[]";

// Function call

if (areBracketsBalanced(exp))

printf("Balanced");

else

printf("Not Balanced");

return 0;

}

// Function to push an item to stack

void push(struct sNode\*\* top\_ref, int new\_data)

{

// allocate node

struct sNode\* new\_node

= (struct sNode\*)malloc(sizeof(struct sNode));

if (new\_node == NULL) {

printf("Stack overflow n");

getchar();

exit(0);

}

// put in the data

new\_node->data = new\_data;

// link the old list off the new node

new\_node->next = (\*top\_ref);

// move the head to point to the new node

(\*top\_ref) = new\_node;

}

// Function to pop an item from stack

int pop(struct sNode\*\* top\_ref)

{

char res;

struct sNode\* top;

// If stack is empty then error

if (\*top\_ref == NULL) {

printf("Stack overflow n");

getchar();

exit(0);

}

else {

top = \*top\_ref;

res = top->data;

\*top\_ref = top->next;

free(top);

return res;

}

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Balanced

// Program to check if the given number is a palindrome using stacks

#include <stdio.h>

#include <stdlib.h>

#include <string.h>

#define MAX 50

int top = -1, front = 0;

int stack[MAX];

void push(char);

void pop();

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int i, choice;

char s[MAX], b;

while (1)

{

printf("1-enter string\n2-exit\n");

printf("enter your choice\n");

scanf("%d", &choice);

switch (choice)

{

case 1:

printf("Enter the String\n");

scanf("%s", s);

for (i = 0;s[i] != '\0';i++)

{

b = s[i];

push(b);

}

for (i = 0;i < (strlen(s) / 2);i++)

{

if (stack[top] == stack[front])

{

pop();

front++;

}

else

{

printf("%s is not a palindrome\n", s);

break;

}

}

if ((strlen(s) / 2) == front)

printf("%s is palindrome\n", s);

front = 0;

top = -1;

break;

case 2:

exit(0);

default:

printf("enter correct choice\n");

}

}

return 0;

}

/\* to push a character into stack \*/

void push(char a)

{

top++;

stack[top] = a;

}

/\* to delete an element in stack \*/

void pop()

{

top--;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

1-enter string

2-exit

enter your choice

1

Enter the String

hellel

hellel is not a palindrome

1-enter string

2-exit

enter your choice

1

Enter the String

mom

mom is palindrome

1-enter string

2-exit

enter your choice

2

// Program to Reverse the given String using Stack

#include <stdio.h>

#include <string.h>

#define max 100

int top,stack[max];

void push(char x){

// Push(Inserting Element in stack) operation

if(top == max-1){

printf("stack overflow");

} else {

stack[++top]=x;

}

}

void pop(){

// Pop (Removing element from stack)

printf("%c",stack[top--]);

}

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

char str[]="sri lanka";

int len = strlen(str);

int i;

for(i=0;i<len;i++)

push(str[i]);

for(i=0;i<len;i++)

pop();

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

aknal irs

**LAB – 14**

// Program for Postfix Evaluation

#include <stdio.h>

#include <ctype.h>

#define MAXSTACK 100 /\* for max size of stack \*/

#define POSTFIXSIZE 100 /\* define max number of charcters in postfix expression \*/

/\* declare stack and its top pointer to be used during postfix expression

evaluation\*/

int stack[MAXSTACK];

int top = -1; /\* because array index in C begins at 0 \*/

/\* can be do this initialization somewhere else \*/

/\* define push operation \*/

void push(int item)

{

if (top >= MAXSTACK - 1) {

printf("stack over flow");

return;

}

else {

top = top + 1;

stack[top] = item;

}

}

/\* define pop operation \*/

int pop()

{

int item;

if (top < 0) {

printf("stack under flow");

}

else {

item = stack[top];

top = top - 1;

return item;

}

}

/\* define function that is used to input postfix expression and to evaluate it \*/

void EvalPostfix(char postfix[])

{

int i;

char ch;

int val;

int A, B;

/\* evaluate postfix expression \*/

for (i = 0; postfix[i] != ')'; i++) {

ch = postfix[i];

if (isdigit(ch)) {

/\* we saw an operand,push the digit onto stack

ch - '0' is used for getting digit rather than ASCII code of digit \*/

push(ch - '0');

}

else if (ch == '+' || ch == '-' || ch == '\*' || ch == '/') {

/\* we saw an operator

\* pop top element A and next-to-top elemnet B

\* from stack and compute B operator A

\*/

A = pop();

B = pop();

switch (ch) /\* ch is an operator \*/

{

case '\*':

val = B \* A;

break;

case '/':

val = B / A;

break;

case '+':

val = B + A;

break;

case '-':

val = B - A;

break;

}

/\* push the value obtained above onto the stack \*/

push(val);

}

}

printf(" \n Result of expression evaluation : %d \n", pop());

}

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int i;

/\* declare character array to store postfix expression \*/

char postfix[POSTFIXSIZE];

printf("ASSUMPTION: There are only four operators(\*, /, +, -) in an expression and operand is single digit only.\n");

printf(" \nEnter postfix expression,\npress right parenthesis ')' for end expression : ");

/\* take input of postfix expression from user \*/

for (i = 0; i <= POSTFIXSIZE - 1; i++) {

scanf("%c", &postfix[i]);

if (postfix[i] == ')') /\* is there any way to eliminate this if \*/

{

break;

} /\* and break statement \*/

}

/\* call function to evaluate postfix expression \*/

EvalPostfix(postfix);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

ASSUMPTION: There are only four operators(\*, /, +, -) in an expression and operand is single digit only.

Enter postfix expression,

press right parenthesis ')' for end expression : 123\*4+56(1+3)

Result of expression evaluation : 3

//Program for Prefix Evaluation

#include<stdio.h>

#include<conio.h>

#include<string.h>

int stk[10];

int top=-1;

void push(int);

int pop();

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

char prefix[10];

int len,val,i,opr1,opr2,res;

printf("Enter the prefix Expression :");

gets(prefix);

len=strlen(prefix);

for(i=len-1;i>=0;i--)

{

switch(get\_type(prefix[i]))

{

case 0:

val=prefix[i]-'0';

push(val);

break;

case 1: opr1=pop();

opr2=pop();

switch(prefix[i])

{

case '+': res=opr1+opr2;

break;

case '-': res=opr1-opr2;

break;

case '\*': res=opr1\*opr2;

break;

case '/': res=opr1/opr2;

break;

}

push(res);

}

}

printf("Result is %d",stk[0]);

getch();

return 0;

}

void push(int val)

{

stk[++top]=val;

}

int pop()

{

return(stk[top--]);

}

int get\_type(char c)

{

if(c=='+'||c=='-'||c=='\*'||c=='/')

return 1;

else

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Input : -+8/632

Output : 8

// Program for Infix to Postfix Coversion

#include<stdio.h>

#include<ctype.h>

char stack[100];

int top = -1;

void push(char x)

{

stack[++top] = x;

}

char pop()

{

if(top == -1)

return -1;

else

return stack[top--];

}

int priority(char x)

{

if(x == '(')

return 0;

if(x == '+' || x == '-')

return 1;

if(x == '\*' || x == '/')

return 2;

return 0;

}

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

char exp[100];

char \*e, x;

printf("Enter the expression : ");

scanf("%s",exp);

printf("\n");

e = exp;

while(\*e != '\0')

{

if(isalnum(\*e))

printf("%c ",\*e);

else if(\*e == '(')

push(\*e);

else if(\*e == ')')

{

while((x = pop()) != '(')

printf("%c ", x);

}

else

{

while(priority(stack[top]) >= priority(\*e))

printf("%c ",pop());

push(\*e);

}

e++;

}

while(top != -1)

{

printf("%c ",pop());

}return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Enter the expression : a+b\*c

a b c \* +

// Program for Infix to Prefix Coversion

#include <stdio.h>

void selection(int arr[], int n)

{

int i, j, small;

for (i = 0; i < n-1; i++) // One by one move boundary of unsorted subarray

{

small = i; //minimum element in unsorted array

for (j = i+1; j < n; j++)

if (arr[j] < arr[small])

small = j;

// Swap the minimum element with the first element

int temp = arr[small];

arr[small] = arr[i];

arr[i] = temp;

}

}

void printArr(int a[], int n) /\* function to print the array \*/

{

int i;

for (i = 0; i < n; i++)

printf("%d ", a[i]);

}

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int a[] = { 12, 31, 25, 8, 32, 17 };

int n = sizeof(a) / sizeof(a[0]);

printf("Before sorting array elements are - \n");

printArr(a, n);

selection(a, n);

printf("\nAfter sorting array elements are - \n");

printArr(a, n);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

\*+ABC

**LAB – 15**

// Program for implementation of 2 stacks using a single Array

#include <stdio.h>

#define SIZE 20

int array[SIZE]; // declaration of array type variable.

int top1 = -1;

int top2 = SIZE;

//Function to push data into stack1

void push1 (int data)

{

// checking the overflow condition

if (top1 < top2 - 1)

{

top1++;

array[top1] = data;

}

else

{

printf ("Stack is full");

}

}

// Function to push data into stack2

void push2 (int data)

{

// checking overflow condition

if (top1 < top2 - 1)

{

top2--;

array[top2] = data;

}

else

{

printf ("Stack is full..\n");

}

}

//Function to pop data from the Stack1

void pop1 ()

{

// Checking the underflow condition

if (top1 >= 0)

{

int popped\_element = array[top1];

top1--;

printf ("%d is being popped from Stack 1\n", popped\_element);

}

else

{

printf ("Stack is Empty \n");

}

}

// Function to remove the element from the Stack2

void pop2 ()

{

// Checking underflow condition

if (top2 < SIZE)

{

int popped\_element = array[top2];

top2--;

printf ("%d is being popped from Stack 1\n", popped\_element);

}

else

{

printf ("Stack is Empty!\n");

}

}

//Functions to Print the values of Stack1

void display\_stack1 ()

{

int i;

for (i = top1; i >= 0; --i)

{

printf ("%d ", array[i]);

}

printf ("\n");

}

// Function to print the values of Stack2

void display\_stack2 ()

{

int i;

for (i = top2; i < SIZE; ++i)

{

printf ("%d ", array[i]);

}

printf ("\n");

}

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int ar[SIZE];

int i;

int num\_of\_ele;

printf ("We can push a total of 20 values\n");

//Number of elements pushed in stack 1 is 10

//Number of elements pushed in stack 2 is 10

// loop to insert the elements into Stack1

for (i = 1; i <= 10; ++i)

{

push1(i);

printf ("Value Pushed in Stack 1 is %d\n", i);

}

// loop to insert the elements into Stack2.

for (i = 11; i <= 20; ++i)

{

push2(i);

printf ("Value Pushed in Stack 2 is %d\n", i);

}

//Print Both Stacks

display\_stack1 ();

display\_stack2 ();

//Pushing on Stack Full

printf ("Pushing Value in Stack 1 is %d\n", 11);

push1 (11);

//Popping All Elements from Stack 1

num\_of\_ele = top1 + 1;

while (num\_of\_ele)

{

pop1 ();

--num\_of\_ele;

}

// Trying to Pop the element From the Empty Stack

pop1 ();

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

We can push a total of 20 values

Value Pushed in Stack 1 is 1

Value Pushed in Stack 1 is 2

Value Pushed in Stack 1 is 3

Value Pushed in Stack 1 is 4

Value Pushed in Stack 1 is 5

Value Pushed in Stack 1 is 6

Value Pushed in Stack 1 is 7

Value Pushed in Stack 1 is 8

Value Pushed in Stack 1 is 9

Value Pushed in Stack 1 is 10

Value Pushed in Stack 2 is 11

Value Pushed in Stack 2 is 12

Value Pushed in Stack 2 is 13

Value Pushed in Stack 2 is 14

Value Pushed in Stack 2 is 15

Value Pushed in Stack 2 is 16

Value Pushed in Stack 2 is 17

Value Pushed in Stack 2 is 18

Value Pushed in Stack 2 is 19

Value Pushed in Stack 2 is 20

10 9 8 7 6 5 4 3 2 1

20 19 18 17 16 15 14 13 12 11

Pushing Value in Stack 1 is 11

Stack is full10 is being popped from Stack 1

9 is being popped from Stack 1

8 is being popped from Stack 1

7 is being popped from Stack 1

6 is being popped from Stack 1

5 is being popped from Stack 1

4 is being popped from Stack 1

3 is being popped from Stack 1

2 is being popped from Stack 1

1 is being popped from Stack 1

Stack is Empty

// Program for Finding Minimum in the Stack

#include <stdio.h>

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int q;

scanf("%d",&q);

int stack[q],stackmin[q];

int top=-1,topmin=-1;

while(q--)

{

int x;scanf("%d",&x);

if(x==1)

{

int y;scanf("%d",&y);

stack[++top]=y;

if(topmin==-1)

stackmin[++topmin]=y;

else if(y<=stackmin[topmin])

stackmin[++topmin]=y;

}

else if(x==2)

{

if(top==-1)

printf("-1\n");

else

{

if(stack[top]==stackmin[topmin])

topmin--;

//printf("%d\n",stack[top]);

top--;}

}

else if(x==3)

{

if(top==-1)

printf("-1\n");

else

printf("%d\n",stack[top]);}

else

{

if(top==-1)

printf("-1\n");

else

printf("%d\n",stackmin[topmin]);}

}

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

4

3

-1

1

2

5

2

3

2

// Program for Sorting of stack

#include <stdio.h>

#include <stdlib.h>

// Stack is represented using linked list

struct stack {

int data;

struct stack\* next;

};

// Utility function to initialize stack

void initStack(struct stack\*\* s) { \*s = NULL; }

// Utility function to check if stack is empty

int isEmpty(struct stack\* s)

{

if (s == NULL)

return 1;

return 0;

}

// Utility function to push an item to stack

void push(struct stack\*\* s, int x)

{

struct stack\* p = (struct stack\*)malloc(sizeof(\*p));

if (p == NULL) {

fprintf(stderr, "Memory allocation failed.\n");

return;

}

p->data = x;

p->next = \*s;

\*s = p;

}

// Utility function to remove an item from stack

int pop(struct stack\*\* s)

{

int x;

struct stack\* temp;

x = (\*s)->data;

temp = \*s;

(\*s) = (\*s)->next;

free(temp);

return x;

}

// Function to find top item

int top(struct stack\* s) { return (s->data); }

// Recursive function to insert an item x in sorted way

void sortedInsert(struct stack\*\* s, int x)

{

// Base case: Either stack is empty or newly inserted

// item is greater than top (more than all existing)

if (isEmpty(\*s) || x > top(\*s)) {

push(s, x);

return;

}

// If top is greater, remove the top item and recur

int temp = pop(s);

sortedInsert(s, x);

// Put back the top item removed earlier

push(s, temp);

}

// Function to sort stack

void sortStack(struct stack\*\* s)

{

// If stack is not empty

if (!isEmpty(\*s)) {

// Remove the top item

int x = pop(s);

// Sort remaining stack

sortStack(s);

// Push the top item back in sorted stack

sortedInsert(s, x);

}

}

// Utility function to print contents of stack

void printStack(struct stack\* s)

{

while (s) {

printf("%d ", s->data);

s = s->next;

}

printf("\n");

}

// Driver code

int main(void)

{

printf("ARYAN ARORA CS-A 2100320120032\n");

struct stack\* top;

initStack(&top);

push(&top, 30);

push(&top, -5);

push(&top, 18);

push(&top, 14);

push(&top, -3);

printf("Stack elements before sorting:\n");

printStack(top);

sortStack(&top);

printf("\n\n");

printf("Stack elements after sorting:\n");

printStack(top);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Stack elements before sorting:

-3 14 18 -5 30

Stack elements after sorting:

30 18 14 -3 -5

// Program for implementation of Multiple stack in one Array

#include<stdio.h>

#include<conio.h>

#define MAX\_X 5

#define MAX\_Y 5

int topx=-1;

int topy=10;

/\*Begin of push\_x\*/

void push\_x(int \*stack)

{

int info;

if(topx>=(MAX\_X-1))

{ printf("\n\nStack OverFlow");

return;

}

else

{ printf("\n\nEnter The info To Push");

scanf("%d",&info);

topx++;

stack[topx]=info;

}}

/\*End of push\_x\*/

/\*Begin of push\_y\*/

void push\_y(int \*stack)

{

int info;

if(topy<=(MAX\_Y))

{

printf("\n\nStack OverFlow");

return;

}

else

{

printf("\n\nEnter The info To Push");

scanf("%d",&info);

topy--;

stack[topy]=info;

}

}

/\*End of push\_y\*/

/\*Begin of pop\_x\*/

void pop\_x(int \*stack)

{ if(topx==-1)

{

printf("Stack X is Underflow");

return;

}

else

{

printf("Item Poped from stack X is:%d\n",stack[topx]);

topx--;

}

}

/\*End of pop\_x\*/

/\*Begin of pop\_y\*/

void pop\_y(int \*stack)

{ if(topy==10)

{printf("Stack y is Underflow");

return;

}

else

{ printf("Item Poped from stack Y is:%d\n",stack[topy]);

topy++;

}}

/\*End of pop\_y\*/

/\*Begin of display\_x\*/

void display\_x(int \*stack)

{

int i;

if(topx==-1)

{

printf("Stack X is Empty");

return;

}

else

{ for(i=topx;i>=0;i--)

{printf("%d,",stack[i]);}

printf("\n");

}}

/\*End of display\_x\*/

/\*Begin of display\_y\*/

void display\_y(int \*stack)

{

int i;

if(topy==10)

{printf("Stack Y is Empty");

return;}

else

{for(i=topy;i<=9;i++)

{

printf("%d,",stack[i]);

}

printf("\n");

} }

/\*End of display\_y\*/

/\*Begin of main\*/

int main()

{ int choice;

char ch;

int stack[MAX\_X+MAX\_Y];

do

{ printf("1.Push\_X\n2.Push\_Y\n");

printf("\n3.Pop\_X\n4.Pop\_Y\n");

printf("\n5.Display\_X\n6.Display\_Y\n");

printf("\n7.Exit");

printf("\n\nEnter Choice");

scanf("%d",&choice);

switch(choice)

{

case 1: push\_x(stack);break;

case 2: push\_y(stack);break;

case 3: pop\_x(stack);break;

case 4: pop\_y(stack);break;

case 5: display\_x(stack);break;

case 6: display\_y(stack);break;

case 7: break;

default: printf("Wrong Option...");

}

}while(choice!=7);

return 0;

}

OUTPUT:

1.Push\_X

2.Push\_Y

3.Pop\_X

4.Pop\_Y

5.Display\_X

6.Display\_Y

7.Exit

Enter Choice1

Enter The info To Push2

1.Push\_X

2.Push\_Y

3.Pop\_X

4.Pop\_Y

5.Display\_X

6.Display\_Y

7.Exit

Enter Choice1

Enter The info To Push3

1.Push\_X

2.Push\_Y

3.Pop\_X

4.Pop\_Y

5.Display\_X

6.Display\_Y

7.Exit

Enter Choice5

3,2,

1.Push\_X

2.Push\_Y

3.Pop\_X

4.Pop\_Y

5.Display\_X

6.Display\_Y

7.Exit

Enter Choice5

3,2,

1.Push\_X

2.Push\_Y

3.Pop\_X

4.Pop\_Y

5.Display\_X

6.Display\_Y

7.Exit

Enter Choice7

**LAB – 16**

// Program of Array Implementaion of Linear Queue

#include<stdio.h>

#define n 5

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int queue[n],ch=1,front=0,rear=0,i,j=1,x=n;

printf("Queue using Array");

printf("\n1.Insertion \n2.Deletion \n3.Display \n4.Exit");

while(ch)

{

printf("\nEnter the Choice:");

scanf("%d",&ch);

switch(ch)

{

case 1:

if(rear==x)

printf("\n Queue is Full");

else

{

printf("\n Enter no %d:",j++);

scanf("%d",&queue[rear++]);

}

break;

case 2:

if(front==rear)

{

printf("\n Queue is empty");

}

else

{

printf("\n Deleted Element is %d",queue[front++]);

x++;

}

break;

case 3:

printf("\nQueue Elements are:\n ");

if(front==rear)

printf("\n Queue is Empty");

else

{

for(i=front; i<rear; i++)

{

printf("%d",queue[i]);

printf("\n");

}

break;

case 4:

return 0;

default:

printf("Wrong Choice: please see the options");

}

}

}

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Queue using Array

1.Insertion

2.Deletion

3.Display

4.Exit

Enter the Choice:1

Enter no 1:2

Enter the Choice:1

Enter no 2:3

Enter the Choice:3

Queue Elements are:

2

3

Enter the Choice:2

Deleted Element is 2

Enter the Choice:2

Deleted Element is 3

// Program of Array Implementaion of CircularQueue

# include<stdio.h>

# define MAX 5

int cqueue\_arr[MAX];

int front = -1;

int rear = -1;

/\*Begin of insert\*/

void insert(int item)

{

if((front == 0 && rear == MAX-1) || (front == rear+1))

{

printf("Queue Overflow \n");

return;

}

if (front == -1) /\*If queue is empty \*/

{

front = 0;

rear = 0;

}

else

{

if(rear == MAX-1) /\*rear is at last position of queue \*/

rear = 0;

else

rear = rear+1;

}

cqueue\_arr[rear] = item ;

}

/\*End of insert\*/

/\*Begin of del\*/

void del()

{

if (front == -1)

{

printf("Queue Underflow\n");

return ;

}

printf("Element deleted from queue is : %d\n",cqueue\_arr[front]);

if(front == rear) /\* queue has only one element \*/

{

front = -1;

rear=-1;

}

else

{

if(front == MAX-1)

front = 0;

else

front = front+1;

}

}

/\*End of del() \*/

/\*Begin of display\*/

void display()

{

int front\_pos = front,rear\_pos = rear;

if(front == -1)

{

printf("Queue is empty\n");

return;

}

printf("Queue elements :\n");

if( front\_pos <= rear\_pos )

while(front\_pos <= rear\_pos)

{

printf("%d ",cqueue\_arr[front\_pos]);

front\_pos++;

}

else

{

while(front\_pos <= MAX-1)

{

printf("%d ",cqueue\_arr[front\_pos]);

front\_pos++;

}

front\_pos = 0;

while(front\_pos <= rear\_pos)

{

printf("%d ",cqueue\_arr[front\_pos]);

front\_pos++;

}

}

printf("\n");

}

/\*End of display\*/

/\*Begin of main\*/

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int choice,item;

do

{

printf("1.Insert\n");

printf("2.Delete\n");

printf("3.Display\n");

printf("4.Quit\n");

printf("Enter your choice : ");

scanf("%d",&choice);

switch(choice)

{

case 1 :

printf("Input the element for insertion in queue : ");

scanf("%d", &item);

insert(item);

break;

case 2 :

del();

break;

case 3:

display();

break;

case 4:

break;

default:

printf("Wrong choice\n");

}

}while(choice!=4);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

1.Insert

2.Delete

3.Display

4.Quit

Enter your choice : 1

Input the element for insertion in queue : 2

1.Insert

2.Delete

3.Display

4.Quit

Enter your choice : 1

Input the element for insertion in queue : 5

1.Insert

2.Delete

3.Display

4.Quit

Enter your choice : 3

Queue elements :

2 5

1.Insert

2.Delete

3.Display

4.Quit

Enter your choice : 4

// Program for ArrayImplementation of Double Ended Queue

#include <stdio.h>

#include <conio.h>

#include <stdlib.h>

#define size 5

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int arr[size],R=-1,F=0,te=0,ch,n,i,x;

for(;;) // An infinite loop

{

system("cls"); // for clearing the screen

printf("F=%d R=%d\n\n",F,R);

printf("1. Add Rear\n");

printf("2. Delete Rear\n");

printf("3. Add Front\n");

printf("4. Delete Front\n");

printf("5. Display\n");

printf("6. Exit\n");

printf("Enter Choice: ");

scanf("%d",&ch);

switch(ch)

{

case 1:

if(te==size)

{

printf("Queue is full");

getch(); // pause the loop to see the message

}

else

{

printf("Enter a number ");

scanf("%d",&n);

R=(R+1)%size;

arr[R]=n;

te=te+1;

}

break;

case 2:

if(te==0)

{

printf("Queue is empty");

getch(); // pause the loop to see the message

}

else

{

if(R==-1)

{

R=size-1;

}

printf("Number Deleted From Rear End = %d",arr[R]);

R=R-1;

te=te-1;

getch(); // pause the loop to see the number

}

break;

case 3:

if(te==size)

{

printf("Queue is full");

getch(); // pause the loop to see the message

}

else

{

printf("Enter a number ");

scanf("%d",&n);

if(F==0)

{

F=size-1;

}

else

{

F=F-1;

}

arr[F]=n;

te=te+1;

}

break;

case 4:

if(te==0)

{

printf("Queue is empty");

getch(); // pause the loop to see the message

}

else

{

printf("Number Deleted From Front End = %d",arr[F]);

F=(F+1)%size;

te=te-1;

getch(); // pause the loop to see the number

}

break;

case 5:

if(te==0)

{

printf("Queue is empty");

getch(); // pause the loop to see the message

}

else

{

x=F;

for(i=1; i<=te; i++)

{

printf("%d ",arr[x]);

x=(x+1)%size;

}

getch(); // pause the loop to see the numbers

}

break;

case 6:

exit(0);

break;

default:

printf("Wrong Choice");

getch(); // pause the loop to see the message

}

}

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

F=0 R=2

1. Add Rear

2. Delete Rear

3. Add Front

4. Delete Front

5. Display

6. Exit

Enter Choice: 5

3 3 4

**LAB – 17**

// Program for Array Implementation of Priority Queue (Ascending Array)

#include<stdio.h>

#include<limits.h>

#define MAX 100

// denotes where the last item in priority queue is

// initialized to -1 since no item is in queue

int idx = -1;

// pqVal holds data for each index item

// pqPriority holds priority for each index item

int pqVal[MAX];

int pqPriority[MAX];

int isEmpty(){

return idx == -1;

}

int isFull(){

return idx == MAX - 1;

}

// enqueue just adds item to the end of the priority queue | O(1)

void enqueue(int data, int priority)

{

if(!isFull()){

// Increase the index

idx++;

// Insert the element in priority queue

pqVal[idx] = data;

pqPriority[idx] = priority;

}

}

// returns item with highest priority

// NOTE: Max Priority Queue High priority number means higher priority | O(N)

int peek()

{

// Note : Max Priority, so assigned min value as initial value

int maxPriority = INT\_MIN;

int indexPos = -1;

// Linear search for highest priority

for (int i = 0; i <= idx; i++) {

// If two items have same priority choose the one with

// higher data value

if (maxPriority == pqPriority[i] && indexPos > -1 && pqVal[indexPos] < pqVal[i])

{

maxPriority = pqPriority[i];

indexPos = i;

}

// note: using MAX Priority so higher priority number

// means higher priority

else if (maxPriority < pqPriority[i]) {

maxPriority = pqPriority[i];

indexPos = i;

}

}

// Return index of the element where

return indexPos;

}

// This removes the element with highest priority

// from the priority queue | O(N)

void dequeue()

{

if(!isEmpty())

{

// Get element with highest priority

int indexPos = peek();

// reduce size of priority queue by first

// shifting all elements one position left

// from index where the highest priority item was found

for (int i = indexPos; i < idx; i++) {

pqVal[i] = pqVal[i + 1];

pqPriority[i] = pqPriority[i + 1];

}

// reduce size of priority queue by 1

idx--;

}

}

void display(){

for (int i = 0; i <= idx; i++) {

printf("(%d, %d)\n",pqVal[i], pqPriority[i]);

}

}

// Driver Code

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

// To enqueue items as per priority

enqueue(5, 1);

enqueue(10, 3);

enqueue(15, 4);

enqueue(20, 5);

enqueue(500, 2);

printf("Before Dequeue : \n");

display();

// Dequeue the top element

dequeue(); // 20 dequeued

dequeue(); // 15 dequeued

printf("\nAfter Dequeue : \n");

display();

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Before Dequeue :

(5, 1)

(10, 3)

(15, 4)

(20, 5)

(500, 2)

After Dequeue :

(5, 1)

(10, 3)

(500, 2)

// Program for Stack implementation using Queue

#include <stdio.h>

#include <stdlib.h>

void push1(int);

void push2(int);

int pop1();

int pop2();

void enqueue();

void dequeue();

void display();

void create();

int st1[100], st2[100];

int top1 = -1, top2 = -1;

int count = 0;

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int ch;

printf("\n1 - Enqueue element into queue");

printf("\n2 - Dequeu element from queue");

printf("\n3 - Display from queue");

printf("\n4 - Exit");

create();

while (1)

{

printf("\nEnter choice");

scanf("%d", &ch);

switch (ch)

{

case 1:

enqueue();

break;

case 2:

dequeue();

break;

case 3:

display();

break;

case 4:

exit(0);

default:

printf("Wrong choice");

}

}

return 0;

}

/\*Function to create a queue\*/

void create()

{

top1 = top2 = -1;

}

/\*Function to push the element on to the stack\*/

void push1(int data)

{

st1[++top1] = data;

}

/\*Function to pop the element from the stack\*/

int pop1()

{

return(st1[top1--]);

}

/\*Function to push an element on to stack\*/

void push2(int data)

{

st2[++top2] = data;

}

/\*Function to pop an element from th stack\*/

int pop2()

{

return(st2[top2--]);

}

/\*Function to add an element into the queue using stack\*/

void enqueue()

{

int data, i;

printf("Enter data into queue");

scanf("%d", &data);

push1(data);

count++;

}

/\*Function to delete an element from the queue using stack\*/

void dequeue()

{

int i;

for (i = 0;i <= count;i++)

{

push2(pop1());

}

pop2();

count--;

for (i = 0;i <= count;i++)

{

push1(pop2());

}

}

/\*Function to display the elements in the stack\*/

void display()

{

int i;

for (i = 0;i <= top1;i++)

{

printf(" %d ", st1[i]);

}

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

1 - Enqueue element into queue

2 - Dequeu element from queue

3 - Display from queue

4 - Exit

Enter choice1

Enter data into queue2

Enter choice1

Enter data into queue5

Enter choice1

Enter data into queue7

Enter choice3

2 5 7

Enter choice4

// Program for Queue implementation using Stack

#include<stdio.h>

#define N 5

int stack1[5], stack2[5]; // declaration of two stacks

// declaration of top variables.

int top1=-1, top2=-1;

int count=0;

// inserting the elements in stack1.

void push1(int data)

{

// Condition to check whether the stack1 is full or not.

if(top1==N-1)

{

printf("\n Stack is overflow...");

}

else

{

top1++; // Incrementing the value of top1

stack1[top1]=data; // pushing the data into stack1

}

}

// Removing the elements from the stack1.

int pop1()

{

// Condition to check whether the stack1 is empty or not.

if(top1==-1)

{

printf("\nStack is empty..");

}

else

{

int a=stack1[top1]; // Assigning the topmost value of stack1 to 'a' variable.

top1--; // decrementing the value of top1.

return a;

}

}

// pushing the data into the stack2.

void push2(int x)

{

// Condition to check whether the stack2 is full or not

if(top2==N-1)

{

printf("\nStack is full..");

}

else

{

top2++; // incrementing the value of top2.

stack2[top2]=x; // assigning the 'x' value to the Stack2

}

}

// Removing the elements from the Stack2

int pop2()

{

int element = stack2[top2]; // assigning the topmost value to element

top2--; // decrement the value of top2

return element;

}

void enqueue(int x)

{

push1(x);

count++;

}

void dequeue()

{

if((top1==-1) && (top2==-1))

{

printf("\nQueue is empty");

}

else

{

for(int i=0;i<count;i++)

{

int element = pop1();

push2(element);

}

int b= pop2();

printf("\nThe dequeued element is %d", b);

printf("\n");

count--;

for(int i=0;i<count;i++)

{

int a = pop2();

push1(a);

}

}}

void display()

{

for(int i=0;i<=top1;i++)

{

printf("%d , ", stack1[i]);

}

}

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

enqueue(10);

enqueue(20);

enqueue(30);

dequeue();

enqueue(40);

display();

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

The dequeued element is 10

20 , 30 , 40

**LAB – 18**

// Program for Linear Linked List Primitive operations

#include <stdio.h>

#include <stdlib.h>

// Create a node

struct Node {

int data;

struct Node\* next;

};

// Insert at the beginning

void insertAtBeginning(struct Node\*\* head\_ref, int new\_data) {

// Allocate memory to a node

struct Node\* new\_node = (struct Node\*)malloc(sizeof(struct Node));

// insert the data

new\_node->data = new\_data;

new\_node->next = (\*head\_ref);

// Move head to new node

(\*head\_ref) = new\_node;

}

// Insert a node after a node

void insertAfter(struct Node\* prev\_node, int new\_data) {

if (prev\_node == NULL) {

printf("the given previous node cannot be NULL");

return;

}

struct Node\* new\_node = (struct Node\*)malloc(sizeof(struct Node));

new\_node->data = new\_data;

new\_node->next = prev\_node->next;

prev\_node->next = new\_node;

}

// Insert the the end

void insertAtEnd(struct Node\*\* head\_ref, int new\_data) {

struct Node\* new\_node = (struct Node\*)malloc(sizeof(struct Node));

struct Node\* last = \*head\_ref; /\* used in step 5\*/

new\_node->data = new\_data;

new\_node->next = NULL;

if (\*head\_ref == NULL) {

\*head\_ref = new\_node;

return;

}

while (last->next != NULL) last = last->next;

last->next = new\_node;

return;

}

// Delete a node

void deleteNode(struct Node\*\* head\_ref, int key) {

struct Node \*temp = \*head\_ref, \*prev;

if (temp != NULL && temp->data == key) {

\*head\_ref = temp->next;

free(temp);

return;

}

// Find the key to be deleted

while (temp != NULL && temp->data != key) {

prev = temp;

temp = temp->next;

}

// If the key is not present

if (temp == NULL) return;

// Remove the node

prev->next = temp->next;

free(temp);

}

// Search a node

int searchNode(struct Node\*\* head\_ref, int key) {

struct Node\* current = \*head\_ref;

while (current != NULL) {

if (current->data == key) return 1;

current = current->next;

}

return 0;

}

// Sort the linked list

void sortLinkedList(struct Node\*\* head\_ref) {

struct Node \*current = \*head\_ref, \*index = NULL;

int temp;

if (head\_ref == NULL) {

return;

} else {

while (current != NULL) {

// index points to the node next to current

index = current->next;

while (index != NULL) {

if (current->data > index->data) {

temp = current->data;

current->data = index->data;

index->data = temp;

}

index = index->next;

}

current = current->next;

}

}

}

// Print the linked list

void printList(struct Node\* node) {

while (node != NULL) {

printf(" %d ", node->data);

node = node->next;

}

}

// Driver program

int main() {

printf("ARYAN ARORA CS-A 2100320120032\n");

struct Node\* head = NULL;

insertAtEnd(&head, 1);

insertAtBeginning(&head, 2);

insertAtBeginning(&head, 3);

insertAtEnd(&head, 4);

insertAfter(head->next, 5);

printf("Linked list: ");

printList(head);

printf("\nAfter deleting an element: ");

deleteNode(&head, 3);

printList(head);

int item\_to\_find = 3;

if (searchNode(&head, item\_to\_find)) {

printf("\n%d is found", item\_to\_find);

} else {

printf("\n%d is not found", item\_to\_find);

}

sortLinkedList(&head);

printf("\nSorted List: ");

printList(head);

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Linked list: 3 2 5 1 4

After deleting an element: 2 5 1 4

3 is not found

Sorted List: 1 2 4 5

//Program for creation of Linked List header file and test of basic functions through that

// C program for a Header Linked List

#include <malloc.h>

#include <stdio.h>

// Structure of the list

struct link {

int info;

struct link\* next;

};

// Empty List

struct link\* start = NULL;

// Function to create a header linked list

struct link\* create\_header\_list(int data)

{

// Create a new node

struct link \*new\_node, \*node;

new\_node = (struct link\*)

malloc(sizeof(struct link));

new\_node->info = data;

new\_node->next = NULL;

// If it is the first node

if (start == NULL) {

// Initialize the start

start = (struct link\*)

malloc(sizeof(struct link));

start->next = new\_node;

}

else {

// Insert the node in the end

node = start;

while (node->next != NULL) {

node = node->next;

}

node->next = new\_node;

}

return start;

}

// Function to display the

// header linked list

struct link\* display()

{

struct link\* node;

node = start;

node = node->next;

while (node != NULL) {

printf("%d ", node->info);

node = node->next;

}

printf("\n");

return start;

}

// Driver code

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

// Create the list

create\_header\_list(11);

create\_header\_list(12);

create\_header\_list(13);

// Print the list

display();

create\_header\_list(14);

create\_header\_list(15);

// Print the list

display();

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

11 12 13

11 12 13 14 15

//Program for finding count of Nodes in Linked List

#include <stdio.h>

//linked list node structure

struct node{

int data;

struct node\* next;

};

struct node\* head;

void insert(int data){

/\* Allocate memory\*/

struct node\* temp = (struct node\*)malloc(sizeof(struct node));

temp->data = data;

temp->next = head;

head = temp;

}

void print(){

struct node\* temp = head;

int count=0;

/\* Traverse the linked list and maintain the count. \*/

while(temp != NULL){

temp = temp->next;

count++;

}

printf("\n Total no. of nodes is %d",count);

}

int main(){

printf("ARYAN ARORA CS-A 2100320120032\n");

head = NULL;

insert(2);

insert(4);

/\* calling print function to print the count of node. \*/

print();

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Total no. of nodes is 2

// Program for concatenation of Linear Linked List

#include <stdio.h>

#include <stdlib.h>

struct node

{

int data;

struct node \*next;

};

display(struct node \*head)

{

if(head == NULL)

{

printf("NULL\n");

}

else

{

printf("%d\n", head -> data);

display(head->next);

}

}

void concatenate(struct node \*a,struct node \*b)

{

if( a != NULL && b!= NULL )

{

if (a->next == NULL)

a->next = b;

else

concatenate(a->next,b);

}

else

{

printf("Either a or b is NULL\n");

}

}

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

struct node \*prev,\*a, \*b, \*p;

int n,i;

printf ("number of elements in a:");

scanf("%d",&n);

a=NULL;

for(i=0;i<n;i++)

{

p=malloc(sizeof(struct node));

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

p->next=NULL;

if(a==NULL)

a=p;

else

prev->next=p;

prev=p;

}

printf ("number of elements in b:");

scanf("%d",&n);

b=NULL;

for(i=0;i<n;i++)

{

p=malloc(sizeof(struct node));

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

p->next=NULL;

if(b==NULL)

b=p;

else

prev->next=p;

prev=p;

}

concatenate(a,b);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

number of elements in a:2

34

45

number of elements in b:3

12

34

56

67

dash: 2: 67: not found

// Program to implement Linear search.

#include <stdio.h>

#include <stdlib.h>

struct Node

{

int data;

struct Node \*next;

} \*first = NULL;

void Create(int A[], int n)

{

int i;

struct Node \*t, \*last;

first = (struct Node \*) malloc(sizeof (struct Node));

first->data = A[0];

first->next = NULL;

last = first;

for (i = 1; i < n; i++)

{

t = (struct Node \*) malloc(sizeof (struct Node));

t->data = A[i];

t->next = NULL;

last->next = t;

last = t;

}

}

struct Node\* LSearch(struct Node \*p, int key)

{

while (p != NULL)

{

if (key == p->data)

return p;

p = p->next;

}

return NULL;

}

struct Node\* RSearch(struct Node \*p, int key)

{

if (p == NULL)

return NULL;

if (key == p->data)

return p;

return RSearch (p->next, key);

}

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

struct Node \*temp;

int A[] = { 8, 3, 7, 12 };

Create(A, 4);

temp = LSearch(first, 7);

printf (" %d", temp->data);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

7

**LAB – 19**

// Program to insert an item at any given position in the linked List

#include<stdio.h>

#include<stdlib.h>

struct Node

{

int data;

struct Node \*next;

};

// required for insertAfter

int getCurrSize (struct Node \*node)

{

int size = 0;

while (node != NULL)

{

node = node->next;

size++;

}

return size;

}

//function to insert after nth node

void insertPosition (int pos, int data, struct Node \*\*head)

{

int size = getCurrSize (\*head);

struct Node \*newNode = (struct Node \*) malloc (sizeof (struct Node));

newNode->data = data;

newNode->next = NULL;

// Can't insert if position to insert is greater than size of Linked List

// can insert after negative pos

if (pos < 0 || pos > size)

printf ("Invalid position to insert\n");

// inserting first node

else if (pos == 0)

{

newNode->next = \*head;

\*head = newNode;

}

else

{

// temp used to traverse the Linked List

struct Node \*temp = \*head;

// traverse till the nth node

while (--pos)

temp = temp->next;

// assign newNode's next to nth node's next

newNode->next = temp->next;

// assign nth node's next to this new node

temp->next = newNode;

// newNode inserted b/w 3rd and 4th node

}

}

void display (struct Node \*node)

{

printf ("Linked List : ");

// as linked list will end when Node is Null

while (node != NULL)

{

printf ("%d ", node->data);

node = node->next;

}

printf ("\n");

}

int main ()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

//creating 4 pointers of type struct Node

//So these can point to address of struct type variable

struct Node \*head = NULL;

struct Node \*node2 = NULL;

struct Node \*node3 = NULL;

struct Node \*node4 = NULL;

// allocate 3 nodes in the heap

head = (struct Node \*) malloc (sizeof (struct Node));

node2 = (struct Node \*) malloc (sizeof (struct Node));

node3 = (struct Node \*) malloc (sizeof (struct Node));

node4 = (struct Node \*) malloc (sizeof (struct Node));

head->data = 10; // data set for head node

head->next = node2; // next pointer assigned to address of node2

node2->data = 20;

node2->next = node3;

node3->data = 30;

node3->next = node4;

node4->data = 40;

node4->next = NULL;

display (head);

//Inserts data: 15 after the 1st node

insertPosition (1, 15, &head);

//Inserts data: 25 after the 3rd node

insertPosition (3, 25, &head);

//Inserts data: 35 after the 5th node

insertPosition (5, 35, &head);

//Inserts data: 25 after the 7th node

insertPosition (7, 45, &head);

display (head);

// Invalid: can't insert after -2 pos

insertPosition (-2, 100, &head);

// Invalid: Current size 8, trying to enter after 10th pos

insertPosition (10, 200, &head);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Linked List : 10 20 30 40

Linked List : 10 15 20 25 30 35 40 45

Invalid position to insert

Invalid position to insert

// Program for Creation of Copy of the Linked list

// C program for the above approach

#include <stdio.h>

#include <stdlib.h>

// Node for linked list

struct Node {

int data;

struct Node\* next;

};

// Function to print given linked list

void printList(struct Node\* head)

{

struct Node\* ptr = head;

while (ptr) {

printf("%d -> ", ptr->data);

ptr = ptr->next;

}

printf("NULL");

}

// Function to create a new node

void insert(struct Node\*\* head\_ref, int data)

{

// Allocate the memory for new Node

// in the heap and set its data

struct Node\* newNode

= (struct Node\*)malloc(

sizeof(struct Node));

newNode->data = data;

// Set the next node pointer of the

// new Node to point to the current

// node of the list

newNode->next = \*head\_ref;

// Change the pointer of head to point

// to the new Node

\*head\_ref = newNode;

}

// Function to create a copy of a linked list

struct Node\* copyList(struct Node\* head)

{

if (head == NULL) {

return NULL;

}

else {

// Allocate the memory for new Node

// in the heap and set its data

struct Node\* newNode

= (struct Node\*)malloc(

sizeof(struct Node));

newNode->data = head->data;

// Recursively set the next pointer of

// the new Node by recurring for the

// remaining nodes

newNode->next = copyList(head->next);

return newNode;

}

}

// Function to create the new linked list

struct Node\* create(int arr[], int N)

{

// Pointer to point the head node

// of the singly linked list

struct Node\* head\_ref = NULL;

// Construct the linked list

for (int i = N - 1; i >= 0; i--) {

insert(&head\_ref, arr[i]);

}

// Return the head pointer

return head\_ref;

}

// Function to create both the lists

void printLists(struct Node\* head\_ref,

struct Node\* dup)

{

printf("Original list: ");

// Print the original linked list

printList(head\_ref);

printf("\nDuplicate list: ");

// Print the duplicate linked list

printList(dup);

}

// Driver Code

int main(void)

{

printf("ARYAN ARORA CS-A 2100320120032\n");

// Given nodes value

int arr[] = { 1, 2, 3, 4, 5 };

int N = sizeof(arr) / sizeof(arr[0]);

// Head of the original Linked list

struct Node\* head\_ref = create(arr, N);

// Head of the duplicate Linked List

struct Node\* dup = copyList(head\_ref);

printLists(head\_ref, dup);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Original list: 1 -> 2 -> 3 -> 4 -> 5 -> NULL

Duplicate list: 1 -> 2 -> 3 -> 4 -> 5 -> NULL

// Program for counting nodes containing even and odd information.

// C program to segregate even and odd nodes in a

// Linked List

#include <stdio.h>

#include <stdlib.h>

/\* a node of the singly linked list \*/

struct Node

{

int data;

struct Node \*next;

};

void segregateEvenOdd(struct Node \*\*head\_ref)

{

struct Node \*end = \*head\_ref;

struct Node \*prev = NULL;

struct Node \*curr = \*head\_ref;

/\* Get pointer to the last node \*/

while (end->next != NULL)

end = end->next;

struct Node \*new\_end = end;

/\* Consider all odd nodes before the first even node

and move then after end \*/

while (curr->data %2 != 0 && curr != end)

{

new\_end->next = curr;

curr = curr->next;

new\_end->next->next = NULL;

new\_end = new\_end->next;

}

// 10->8->17->17->15

/\* Do following steps only if there is any even node \*/

if (curr->data%2 == 0)

{

/\* Change the head pointer to point to first even node \*/

\*head\_ref = curr;

/\* now current points to the first even node \*/

while (curr != end)

{

if ( (curr->data)%2 == 0 )

{

prev = curr;

curr = curr->next;

}

else

{

/\* break the link between prev and current \*/

prev->next = curr->next;

/\* Make next of curr as NULL \*/

curr->next = NULL;

/\* Move curr to end \*/

new\_end->next = curr;

/\* make curr as new end of list \*/

new\_end = curr;

/\* Update current pointer to next of the moved node \*/

curr = prev->next;

}

}

}

/\* We must have prev set before executing lines following this

statement \*/

else prev = curr;

/\* If there are more than 1 odd nodes and end of original list is

odd then move this node to end to maintain same order of odd

numbers in modified list \*/

if (new\_end!=end && (end->data)%2 != 0)

{

prev->next = end->next;

end->next = NULL;

new\_end->next = end;

}

return;

}

/\* UTILITY FUNCTIONS \*/

/\* Function to insert a node at the beginning \*/

void push(struct Node\*\* head\_ref, int new\_data)

{

/\* allocate node \*/

struct Node\* new\_node =

(struct Node\*) malloc(sizeof(struct Node));

/\* put in the data \*/

new\_node->data = new\_data;

/\* link the old list of the new node \*/

new\_node->next = (\*head\_ref);

/\* move the head to point to the new node \*/

(\*head\_ref) = new\_node;

}

/\* Function to print nodes in a given linked list \*/

void printList(struct Node \*node)

{

while (node!=NULL)

{

printf("%d ", node->data);

node = node->next;

}

}

/\* Driver program to test above functions\*/

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

/\* Start with the empty list \*/

struct Node\* head = NULL;

/\* Let us create a sample linked list as following

0->2->4->6->8->10->11 \*/

push(&head, 11);

push(&head, 10);

push(&head, 8);

push(&head, 6);

push(&head, 4);

push(&head, 2);

push(&head, 0);

printf("\nOriginal Linked list \n");

printList(head);

segregateEvenOdd(&head);

printf("\nModified Linked list \n");

printList(head);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Original Linked list

0 2 4 6 8 10 11

Modified Linked list

0 2 4 6 8 10 11

// Program for Creation of Ascending Order Linear Linked List

#include<stdio.h>

#include<stdlib.h>

typedef struct node

{

int data;

struct node\*next;

}node;

void add(node\*\*s,int num)

{

node\*temp;

if(\*s==NULL||num<(\*s)->data)

{

temp=(node\*)malloc(sizeof(node));

temp->data=num;

temp->next=\*s;

\*s=temp;

}

else

{

temp=\*s;

while(temp!=NULL)

{

if(temp->data<=num&&(temp->next==NULL || temp->next->data>num))

{

node\*temp1=(node\*)malloc(sizeof(node));

temp1->data=num;

temp1->next=temp->next;

temp->next=temp1;

return;

}

temp=temp->next;

}

}

}

void traverse(node\*s)

{

while(s!=NULL)

{

printf("%d\t",s->data);

s=s->next;

}

}

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

node\*n=NULL;

add(&n,5);

add(&n,7);

add(&n,18);

add(&n,12);

add(&n,78);

add(&n,-13);

traverse(n);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

-13 5 7 12 18 78

// Program for Merging two sorted Linked List/unsoted link list

#include <stdio.h>

#include <stdlib.h>

struct Node

{

int data;

struct Node \*next;

} \*temp = NULL, \*first = NULL, \*second = NULL, \*third = NULL, \*last = NULL;

struct Node\* Create (int A[], int n)

{

int i;

struct Node \*t, \*last;

temp = (struct Node \*) malloc(sizeof(struct Node));

temp->data = A[0];

temp->next = NULL;

last = temp;

for (i = 1; i < n; i++)

{

t = (struct Node \*) malloc(sizeof(struct Node));

t->data = A[i];

t->next = NULL;

last->next = t;

last = t;

}

return temp;

}

void Display(struct Node \*p)

{

while (p != NULL)

{

printf ("%d ", p->data);

p = p->next;

}

}

void Merge(struct Node \*first, struct Node \*second)

{

if (first->data < second->data)

{

third = last = first;

first = first->next;

last->next = NULL;

}

else

{

third = last = second;

second = second->next;

last->next = NULL;

}

while (first != NULL && second != NULL)

{

if (first->data < second->data)

{

last->next = first;

last = first;

first = first->next;

last->next = NULL;

}

else

{

last->next = second;

last = second;

second = second->next;

last->next = NULL;

}

}

if (first != NULL)

last->next = first;

else

last->next = second;

}

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int A[] = { 3, 4, 7, 9 };

int B[] = { 2, 5, 6, 8 };

first = Create (A, 4);

second = Create (B, 4);

printf ("1st Linked List: ");

Display (first);

printf ("\n2nd Linked List: ");

Display (second);

Merge (first, second);

printf ("\n\nMerged Linked List: \n");

Display (third);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

1st Linked List: 3 4 7 9

2nd Linked List: 2 5 6 8

Merged Linked List:

2 3 4 5 6 7 8 9

// Program for finding difference of two linked list (consider lists as sets)

print("ARYAN ARORA CS-A 2100320120032\n");

class Node:

def \_\_init\_\_(self, data):

self.data = data

self.next = None

# Linked List

class linked\_list:

def \_\_init\_\_(self):

self.head = None

# Function to insert a node

# at the end of Linked List

def append(self, data):

temp = Node(data)

if self.head == None:

self.head = temp

else:

p = self.head

while p.next != None:

p = p.next

p.next = temp

# Function to find the middle

# node of the Linked List

def get\_mid(self, head):

if head == None:

return head

slow = fast = head

while fast.next != None \

and fast.next.next != None:

slow = slow.next

fast = fast.next.next

return slow

# Recursive method to merge the

# two half after sorting

def merge(self, l, r):

if l == None:return r

if r == None:return l

if l.data<= r.data:

result = l

result.next = \

self.merge(l.next, r)

else:

result = r

result.next = \

self.merge(l, r.next)

return result

# Recursive method to divide the

# list into two half until 1 node left

def merge\_sort(self, head):

if head == None or head.next == None:

return head

mid = self.get\_mid(head)

next\_to\_mid = mid.next

mid.next = None

left = self.merge\_sort(head)

right = self.merge\_sort(next\_to\_mid)

sorted\_merge = self.merge(left, right)

return sorted\_merge

# Function to print the list elements

def display(self):

p = self.head

while p != None:

print(p.data, end =' ')

p = p.next

print()

# Function to get the difference list

def get\_difference(p1, p2):

difference\_list = linked\_list()

# Scan the lists

while p1 != None and p2 != None:

# Condition to check if the

# Data of the both pointer are

# same then move ahead

if p2.data == p1.data:

p1 = p1.next

p2 = p2.next

# Condition to check if the

# Data of the first pointer is

# greater than second then

# move second pointer ahead

elif p2.data<p1.data:

p2 = p2.next

# Condition when first pointer

# data is greater than the

# second pointer then append

# into the difference list and move

else:

difference\_list.append(p1.data)

p1 = p1.next

# If end of list2 is reached,

# there may be some nodes in

# List 1 left to be scanned,

# they all will be inserted

# in the difference list

if p2 == None:

while p1:

difference\_list.append(p1.data)

p1 = p1.next

return difference\_list

# Driver Code

if \_\_name\_\_ == '\_\_main\_\_':

# Linked List 1

list1 = linked\_list()

list1.append(2)

list1.append(6)

list1.append(8)

list1.append(1)

# Linked List 2

list2 = linked\_list()

list2.append(4)

list2.append(1)

list2.append(9)

# Sort both the linkedlists

list1.head = list1.merge\_sort(

list1.head

)

list2.head = list2.merge\_sort(

list2.head

)

# Get difference list

result = get\_difference(

list1.head, list2.head

)

if result.head:

result.display()

# if difference list is empty,

# then lists are equal

else:

print('Lists are equal')

OUTPUT:

ARYAN ARORA CS-A 2100320120032

2 6 8

**LAB – 20**

//Program for Finding the Middle element of a singly linked list in one pass

#include<stdio.h>

#include<stdlib.h>

// Link list node

struct Node

{

int data;

struct Node\* next;

};

// Function to get the middle of

// the linked list

void printMiddle(struct Node \*head)

{

struct Node \*slow\_ptr = head;

struct Node \*fast\_ptr = head;

if (head!=NULL)

{

while (fast\_ptr != NULL &&

fast\_ptr->next != NULL)

{

fast\_ptr = fast\_ptr->next->next;

slow\_ptr = slow\_ptr->next;

}

printf("The middle element is [%d]",

slow\_ptr->data);

}

}

void push(struct Node\*\* head\_ref,

int new\_data)

{

// Allocate node

struct Node\* new\_node =

(struct Node\*) malloc(sizeof(struct Node));

// Put in the data

new\_node->data = new\_data;

// Link the old list off the new node

new\_node->next = (\*head\_ref);

// Move the head to point to the new node

(\*head\_ref) = new\_node;

}

// A utility function to print a given

// linked list

void printList(struct Node \*ptr)

{

while (ptr != NULL)

{

printf("%d->", ptr->data);

ptr = ptr->next;

}

printf("NULL");

}

// Driver code

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

// Start with the empty list

struct Node\* head = NULL;

int i;

for (i = 5; i > 0; i--)

{

push(&head, i);

printList(head);

printMiddle(head);

}

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

5->NULLThe middle element is [5]4->5->NULLThe middle element is [5]3->4->5->NULLThe middle element is [4]2->3->4->5->NULLThe middle element is [4]1->2->3->4->5->NULLThe middle element is [3]

//Program to perform Binary Search on the Linked List

#include<stdio.h>

#include<stdlib.h>

struct Node

{

int data;

struct Node\* next;

};

struct Node \*newNode(int x)

{

struct Node\* temp = (struct Node\*)malloc(sizeof(struct Node));

temp->data = x;

temp->next = NULL;

return temp;

}

// function to find out middle element

struct Node\* middle(struct Node\* start,struct Node\* last)

{

if (start == NULL)

return NULL;

struct Node\* slow = start;

struct Node\* fast = start -> next;

while (fast != last)

{

fast = fast -> next;

if (fast != last)

{

slow = slow -> next;

fast = fast -> next;

}

}

return slow;

}

// Function for implementing the Binary

// Search on linked list

struct Node\* binarySearch(struct Node \*head, int value)

{

struct Node\* start = head;

struct Node\* last = NULL;

do

{

// Find middle

struct Node\* mid = middle(start, last);

// If middle is empty

if (mid == NULL)

return NULL;

// If value is present at middle

if (mid -> data == value)

return mid;

// If value is more than mid

else if (mid -> data < value)

start = mid -> next;

// If the value is less than mid.

else

last = mid;

} while (last == NULL ||

last != start);

// value not present

return NULL;

}

// Driver Code

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

struct Node \*head = newNode(1);

head->next = newNode(4);

head->next->next = newNode(7);

head->next->next->next = newNode(8);

head->next->next->next->next = newNode(9);

head->next->next->next->next->next = newNode(10);

int value = 8;

if (binarySearch(head, value) == NULL)

printf("Value not present\n");

else

printf("Present");

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Present

//Program for Reversing the Linear Linked List

#include <stdio.h>

#include <stdlib.h>

/\* Link list node \*/

struct Node {

int data;

struct Node\* next;

};

/\* Function to reverse the linked list \*/

static void reverse(struct Node\*\* head\_ref)

{

struct Node\* prev = NULL;

struct Node\* current = \*head\_ref;

struct Node\* next = NULL;

while (current != NULL) {

// Store next

next = current->next;

// Reverse current node's pointer

current->next = prev;

// Move pointers one position ahead.

prev = current;

current = next;

}

\*head\_ref = prev;

}

/\* Function to push a node \*/

void push(struct Node\*\* head\_ref, int new\_data)

{

struct Node\* new\_node

= (struct Node\*)malloc(sizeof(struct Node));

new\_node->data = new\_data;

new\_node->next = (\*head\_ref);

(\*head\_ref) = new\_node;

}

/\* Function to print linked list \*/

void printList(struct Node\* head)

{

struct Node\* temp = head;

while (temp != NULL) {

printf("%d ", temp->data);

temp = temp->next;

}

}

/\* Driver code\*/

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

/\* Start with the empty list \*/

struct Node\* head = NULL;

push(&head, 20);

push(&head, 4);

push(&head, 15);

push(&head, 85);

printf("Given linked list\n");

printList(head);

reverse(&head);

printf("\nReversed linked list \n");

printList(head);

getchar();

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Given linked list

85 15 4 20

Reversed linked list

20 4 15 85

//Program to print Linked List contents in reverse order

#include<stdio.h>

#include<stdlib.h>

struct node //code for making a node

{

int data;

struct node \*next;

};

void display (struct node \*head) //method for reverse display nodes

{

if (head == NULL)

return;

// print the list after head node

display (head->next);

// After everything else is printed, print head

printf ("%d ", head->data);

}

int main ()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

struct node \*prev, \*head, \*p;

int n, i;

printf ("Enter size of Linked List: ");

scanf ("%d", &n);

head = NULL;

for (i = 0; i < n; i++)

{

p = malloc (sizeof (struct node));

printf ("Enter the data: ");

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

p->next = NULL;

if (head == NULL)

head = p;

else

prev->next = p;

prev = p;

}

display (head);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Enter size of Linked List: 5

Enter the data: 1

2Enter the data:

34

Enter the data: 56

Enter the data: 67

Enter the data: 78

78 67 56 34 1

//Program for Pair wise swap of elements in linked list

#include <stdio.h>

#include <stdlib.h>

/\* A linked list node \*/

struct Node {

int data;

struct Node\* next;

};

/\*Function to swap two integers at addresses a and b \*/

void swap(int\* a, int\* b);

/\* Function to pairwise swap elements of a linked list \*/

void pairWiseSwap(struct Node\* head)

{

struct Node\* temp = head;

/\* Traverse further only if there are at-least two nodes left \*/

while (temp != NULL && temp->next != NULL) {

/\* Swap data of node with its next node's data \*/

swap(&temp->data, &temp->next->data);

/\* Move temp by 2 for the next pair \*/

temp = temp->next->next;

}

}

/\* UTILITY FUNCTIONS \*/

/\* Function to swap two integers \*/

void swap(int\* a, int\* b)

{

int temp;

temp = \*a;

\*a = \*b;

\*b = temp;

}

/\* Function to add a node at the beginning of Linked List \*/

void push(struct Node\*\* head\_ref, int new\_data)

{

/\* allocate node \*/

struct Node\* new\_node = (struct Node\*)malloc(sizeof(struct Node));

/\* put in the data \*/

new\_node->data = new\_data;

/\* link the old list of the new node \*/

new\_node->next = (\*head\_ref);

/\* move the head to point to the new node \*/

(\*head\_ref) = new\_node;

}

/\* Function to print nodes in a given linked list \*/

void printList(struct Node\* node)

{

while (node != NULL) {

printf("%d ", node->data);

node = node->next;

}

}

/\* Driver program to test above function \*/

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

struct Node\* start = NULL;

/\* The constructed linked list is:

1->2->3->4->5 \*/

push(&start, 5);

push(&start, 4);

push(&start, 3);

push(&start, 2);

push(&start, 1);

printf("Linked list before calling pairWiseSwap()\n");

printList(start);

pairWiseSwap(start);

printf("\nLinked list after calling pairWiseSwap()\n");

printList(start);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Linked list before calling pairWiseSwap()

1 2 3 4 5

Linked list after calling pairWiseSwap()

2 1 4 3 5

//Program to find kth node from the last in a single link list

#include <stdio.h>

#include <stdlib.h>

/\* Link list node \*/

typedef struct Node {

int data;

struct Node\* next;

} Node;

/\* Function to get the nth node from the last of a linked

\* list\*/

void printNthFromLast(Node\* head, int N)

{

int len = 0, i;

Node\* temp = head;

// Count the number of nodes in Linked List

while (temp != NULL) {

temp = temp->next;

len++;

}

// Check if value of N is not

// more than length of the linked list

if (len < N)

return;

temp = head;

// Get the (len-N+1)th node from the beginning

for (i = 1; i < len - N + 1; i++)

temp = temp->next;

printf("%d", temp->data);

return;

}

void push(struct Node\*\* head\_ref, int new\_data)

{

/\* Allocate node \*/

Node\* new\_node = (Node\*)malloc(sizeof(Node));

/\* Put in the data \*/

new\_node->data = new\_data;

/\* link the old list of the new node \*/

new\_node->next = (\*head\_ref);

/\* move the head to point to the new node \*/

(\*head\_ref) = new\_node;

}

// Driver's Code

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

/\* Start with the empty list \*/

struct Node\* head = NULL;

// create linked 35->15->4->20

push(&head, 20);

push(&head, 4);

push(&head, 15);

push(&head, 35);

// Function call

printNthFromLast(head, 4);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

35

//Program for Sorting the Linear Linked List

#include <stdio.h>

//Represent a node of the singly linked list

struct node{

int data;

struct node \*next;

};

//Represent the head and tail of the singly linked list

struct node \*head, \*tail = NULL;

//addNode() will add a new node to the list

void addNode(int data) {

//Create a new node

struct node \*newNode = (struct node\*)malloc(sizeof(struct node));

newNode->data = data;

newNode->next = NULL;

//Checks if the list is empty

if(head == NULL) {

//If list is empty, both head and tail will point to new node

head = newNode;

tail = newNode;

}

else {

//newNode will be added after tail such that tail's next will point to newNode

tail->next = newNode;

//newNode will become new tail of the list

tail = newNode;

}

}

//sortList() will sort nodes of the list in ascending order

void sortList() {

//Node current will point to head

struct node \*current = head, \*index = NULL;

int temp;

if(head == NULL) {

return;

}

else {

while(current != NULL) {

//Node index will point to node next to current

index = current->next;

while(index != NULL) {

//If current node's data is greater than index's node data, swap the data between them

if(current->data > index->data) {

temp = current->data;

current->data = index->data;

index->data = temp;

}

index = index->next;

}

current = current->next;

}

}

}

//display() will display all the nodes present in the list

void display() {

//Node current will point to head

struct node \*current = head;

if(head == NULL) {

printf("List is empty \n");

return;

}

while(current != NULL) {

//Prints each node by incrementing pointer

printf("%d ", current->data);

current = current->next;

}

printf("\n");

}

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

//Adds data to the list

addNode(9);

addNode(7);

addNode(2);

addNode(5);

addNode(4);

//Displaying original list

printf("Original list: \n");

display();

//Sorting list

sortList();

//Displaying sorted list

printf("Sorted list: \n");

display();

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Original list:

9 7 2 5 4

Sorted list:

2 4 5 7 9

**LAB - 21**

// Program to Detect if there is ay cycle in the linked list, starting point of cycle, length of cycle

#include <stdio.h>

#include <stdlib.h>

/\* A structure of linked list node \*/

struct node {

int data;

struct node \*next;

} \*head;

void initialize(){

head = NULL;

}

/\*

Given a Inserts a node in front of a singly linked list.

\*/

void insert(int num) {

/\* Create a new Linked List node \*/

struct node\* newNode = (struct node\*) malloc(sizeof(struct node));

newNode->data = num;

/\* Next pointer of new node will point to head node of linked list \*/

newNode->next = head;

/\* make new node as new head of linked list \*/

head = newNode;

printf("Inserted Element : %d\n", num);

}

void findloop(struct node \*head) {

struct node \*slow, \*fast;

slow = fast = head;

while(slow && fast && fast->next) {

/\* Slow pointer will move one node per iteration whereas

fast node will move two nodes per iteration \*/

slow = slow->next;

fast = fast->next->next;

if (slow == fast) {

printf("Linked List contains a loop\n");

return;

}

}

printf("No Loop in Linked List\n");

}

/\*

Prints a linked list from head node till tail node

\*/

void printLinkedList(struct node \*nodePtr) {

while (nodePtr != NULL) {

printf("%d", nodePtr->data);

nodePtr = nodePtr->next;

if(nodePtr != NULL)

printf("-->");

}

}

int main() {

printf("ARYAN ARORA CS-A 2100320120032\n");

initialize();

/\* Creating a linked List\*/

insert(8);

insert(3);

insert(2);

insert(7);

insert(9);

/\* Create loop in linked list. Set next pointer of last node to second node from head \*/

head->next->next->next->next->next = head->next;

findloop(head);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Inserted Element : 8

Inserted Element : 3

Inserted Element : 2

Inserted Element : 7

Inserted Element : 9

Linked List contains a loop

// Program for Delete duplicate nodes in the Linked List

#include <stdio.h>

//Represent a node of the singly linked list

struct node{

int data;

struct node \*next;

};

//Represent the head and tail of the singly linked list

struct node \*head, \*tail = NULL;

//addNode() will add a new node to the list

void addNode(int data) {

//Create a new node

struct node \*newNode = (struct node\*)malloc(sizeof(struct node));

newNode->data = data;

newNode->next = NULL;

//Checks if the list is empty

if(head == NULL) {

//If list is empty, both head and tail will point to new node

head = newNode;

tail = newNode;

}

else {

//newNode will be added after tail such that tail's next will point to newNode

tail->next = newNode;

//newNode will become new tail of the list

tail = newNode;

}

}

//removeDuplicate() will remove duplicate nodes from the list

void removeDuplicate() {

//Node current will point to head

struct node \*current = head, \*index = NULL, \*temp = NULL;

if(head == NULL) {

return;

}

else {

while(current != NULL){

//Node temp will point to previous node to index.

temp = current;

//Index will point to node next to current

index = current->next;

while(index != NULL) {

//If current node's data is equal to index node's data

if(current->data == index->data) {

//Here, index node is pointing to the node which is duplicate of current node

//Skips the duplicate node by pointing to next node

temp->next = index->next;

}

else {

//Temp will point to previous node of index.

temp = index;

}

index = index->next;

}

current = current->next;

}

}

}

//display() will display all the nodes present in the list

void display() {

//Node current will point to head

struct node \*current = head;

if(head == NULL) {

printf("List is empty \n");

return;

}

while(current != NULL) {

//Prints each node by incrementing pointer

printf("%d ", current->data);

current = current->next;

}

printf("\n");

}

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

//Adds data to the list

addNode(1);

addNode(2);

addNode(3);

addNode(2);

addNode(2);

addNode(4);

addNode(1);

printf("Originals list: \n");

display();

//Removes duplicate nodes

removeDuplicate();

printf("List after removing duplicates: \n");

display();

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Originals list:

1 2 3 2 2 4 1

List after removing duplicates:

1 2 3 4

// Program for Linked List Implementaion of Priority Queue

#include <stdio.h>

#include <stdlib.h>

// Node

typedef struct node {

int data;

// Lower values indicate higher priority

int priority;

struct node\* next;

} Node;

// Function to Create A New Node

Node\* newNode(int d, int p)

{

Node\* temp = (Node\*)malloc(sizeof(Node));

temp->data = d;

temp->priority = p;

temp->next = NULL;

return temp;

}

// Return the value at head

int peek(Node\*\* head)

{

return (\*head)->data;

}

// Removes the element with the

// highest priority from the list

void pop(Node\*\* head)

{

Node\* temp = \*head;

(\*head) = (\*head)->next;

free(temp);

}

// Function to push according to priority

void push(Node\*\* head, int d, int p)

{

Node\* start = (\*head);

// Create new Node

Node\* temp = newNode(d, p);

// Special Case: The head of list has lesser

// priority than new node. So insert new

// node before head node and change head node.

if ((\*head)->priority > p) {

// Insert New Node before head

temp->next = \*head;

(\*head) = temp;

}

else {

// Traverse the list and find a

// position to insert new node

while (start->next != NULL &&

start->next->priority < p) {

start = start->next;

}

// Either at the ends of the list

// or at required position

temp->next = start->next;

start->next = temp;

}

}

// Function to check is list is empty

int isEmpty(Node\*\* head)

{

return (\*head) == NULL;

}

// Driver code

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

// Create a Priority Queue

// 7->4->5->6

Node\* pq = newNode(4, 1);

push(&pq, 5, 2);

push(&pq, 6, 3);

push(&pq, 7, 0);

while (!isEmpty(&pq)) {

printf("%d ", peek(&pq));

pop(&pq);

}

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

7 4 5 6

// Program to arrange the consonats and vowel nodes of the linked list it in such a way that all the vowels nodes come before the consonats while maintaining the order of their arrival

#include<stdio.h>

#include<stdlib.h>

#include<stdbool.h>

/\* A linked list node \*/

struct Node

{

char data;

struct Node \*next;

};

/\* Function to add new node to the List \*/

struct Node \*newNode(char key)

{

struct Node \*temp = (struct Node\*)malloc(sizeof(struct Node));

temp->data = key;

temp->next = NULL;

return temp;

}

// utility function to print linked list

void printlist(struct Node \*head)

{

if (! head)

{

printf("Empty list \n");

return;

}

while (head != NULL)

{

printf("%c",head->data);

if (head->next)

printf("->");

head = head->next;

}

printf("\n");

}

// utility function for checking vowel

bool isVowel(char x)

{

return (x == 'a' || x == 'e' || x == 'i' ||

x == 'o' || x == 'u');

}

/\* function to arrange consonants and

vowels nodes \*/

struct Node \*arrange(struct Node \*head)

{

struct Node \*newHead = head;

// for keep track of vowel

struct Node \*latestVowel;

struct Node \*curr = head;

// list is empty

if (head == NULL)

return NULL;

// We need to discover the first vowel

// in the list. It is going to be the

// returned head, and also the initial

// latestVowel.

if (isVowel(head->data))

// first element is a vowel. It will

// also be the new head and the initial

// latestVowel;

latestVowel = head;

else

{

// First element is not a vowel. Iterate

// through the list until we find a vowel.

// Note that curr points to the element

// \*before\* the element with the vowel.

while (curr->next != NULL &&

!isVowel(curr->next->data))

curr = curr->next;

// This is an edge case where there are

// only consonants in the list.

if (curr->next == NULL)

return head;

// Set the initial latestVowel and the

// new head to the vowel item that we found.

// Relink the chain of consonants after

// that vowel item:

// old\_head\_consonant->consonant1->consonant2->

// vowel->rest\_of\_list becomes

// vowel->old\_head\_consonant->consonant1->

// consonant2->rest\_of\_list

latestVowel = newHead = curr->next;

curr->next = curr->next->next;

latestVowel->next = head;

}

// Now traverse the list. Curr is always the item

// \*before\* the one we are checking, so that we

// can use it to re-link.

while (curr != NULL && curr->next != NULL)

{

if (isVowel(curr->next->data))

{

// The next discovered item is a vowel

if (curr == latestVowel)

{

// If it comes directly after the

// previous vowel, we don't need to

// move items around, just mark the

// new latestVowel and advance curr.

latestVowel = curr = curr->next;

}

else

{

// But if it comes after an intervening

// chain of consonants, we need to chain

// the newly discovered vowel right after

// the old vowel. Curr is not changed as

// after the re-linking it will have a

// new next, that has not been checked yet,

// and we always keep curr at one before

// the next to check.

struct Node \*temp = latestVowel->next;

// Chain in new vowel

latestVowel->next = curr->next;

// Advance latestVowel

latestVowel = latestVowel->next;

// Remove found vowel from previous place

curr->next = curr->next->next;

// Re-link chain of consonants after latestVowel

latestVowel->next = temp;

}

}

else

{

// No vowel in the next element, advance curr.

curr = curr->next;

}

}

return newHead;

}

// Driver code

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

struct Node \*head = newNode('a');

head->next = newNode('b');

head->next->next = newNode('c');

head->next->next->next = newNode('e');

head->next->next->next->next = newNode('d');

head->next->next->next->next->next = newNode('o');

head->next->next->next->next->next->next = newNode('x');

head->next->next->next->next->next->next->next = newNode('i');

printf("Linked list before :\n");

printlist(head);

head = arrange(head);

printf("Linked list after :\n");

printlist(head);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Linked list before :

a->b->c->e->d->o->x->i

Linked list after :

a->e->o->i->b->c->d->x

// Program for Deletion of all occuraces of x from Linked List

#include <stdio.h>

#include <stdlib.h>

// A linked list node

typedef struct Node {

int data;

struct Node\* next;

} Node;

/\* Given a reference (pointer to pointer) to the head of a

list and an int, inserts a new node on the front of the

list. \*/

void push(struct Node\*\* head\_ref, int new\_data)

{

struct Node\* new\_node

= (struct Node\*)malloc(sizeof(struct Node));

new\_node->data = new\_data;

new\_node->next = (\*head\_ref);

(\*head\_ref) = new\_node;

}

/\* Given a reference (pointer to pointer) to the head of a

list and a key, deletes all occurrence of the given key

in linked list \*/

Node\* deleteKey(Node\* head, int x)

{

if (!head)

return head;

// Until the head data is equal to the key move the head

// pointer

while (head && head->data == x)

head = head->next;

Node \*curr = head, \*prev = NULL;

while (curr) {

if (curr->data == x)

prev->next = curr->next;

else

prev = curr;

curr = curr->next;

}

return head;

}

// This function prints contents of linked list starting

// from the given node

void printList(Node\* node)

{

while (node != NULL) {

printf(" %d ", node->data);

node = node->next;

}

}

// Driver code

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

// Start with the empty list

struct Node\* head = NULL;

push(&head, 7);

push(&head, 2);

push(&head, 3);

push(&head, 2);

push(&head, 8);

push(&head, 1);

push(&head, 2);

push(&head, 2);

int key = 2; // key to delete

puts("Created Linked List: ");

printList(head);

// Function call

head = deleteKey(head, key);

if (!head)

printf("\nNo element present in the Linked list\n");

else {

printf("\nLinked List after Deletion is:\n");

printList(head);

}

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Created Linked List:

2 2 1 8 2 3 2 7

Linked List after Deletion is:

1 8 3 7

// Program to Delete kth node from end of a linked list in a single scan and O(n) time

#include <assert.h>

#include <stdio.h>

#include <stdlib.h>

/\* Link list node \*/

typedef struct Node {

int data;

struct Node\* next;

} Node;

Node\* deleteNode(Node\* head, int key)

{

// We will be using this pointer for holding address

// temporarily while we delete the node

Node\* temp;

// First pointer will point to the head of the linked

// list

Node\* first = head;

// Second pointer will point to the Nth node from the

// beginning

Node\* second = head;

for (int i = 0; i < key; i++) {

// If count of nodes in the given linked list is <=N

if (second->next == NULL) {

// If count = N i.e. delete the head node

if (i == key - 1) {

temp = head;

head = head->next;

free(temp);

}

return head;

}

second = second->next;

}

// Increment both the pointers by one until

// second pointer reaches the end

while (second->next != NULL) {

first = first->next;

second = second->next;

}

// First must be pointing to the Nth node from the end

// by now So, delete the node first is pointing to

temp = first->next;

first->next = first->next->next;

free(temp);

return head;

}

/\* Function to insert a node at the beginning of the

linked list \*/

void push(Node\*\* head\_ref, int new\_data)

{

/\* allocate node \*/

Node\* new\_node = (Node\*)malloc(sizeof(Node));

/\* put in the data \*/

new\_node->data = new\_data;

/\* link the old list off the new node \*/

new\_node->next = (\*head\_ref);

/\* move the head to point to the new node \*/

(\*head\_ref) = new\_node;

}

/\* Function to print nodes in a given linked list \*/

void printList(struct Node\* node)

{

while (node != NULL) {

printf("%d ", node->data);

node = node->next;

}

}

// Driver program

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

struct Node\* head = NULL;

push(&head, 7);

push(&head, 1);

push(&head, 3);

push(&head, 2);

printf("Created Linked list is:\n");

printList(head);

int n = 1;

deleteNode(head, n);

printf("\nLinked List after Deletion is:\n");

printList(head);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Created Linked list is:

2 3 1 7

Linked List after Deletion is:

2 3 1

**LAB – 22**

// Program to find out the addition of two given link list 125+85 =210 1->2->5 8->5

#include <stdio.h>

#include <stdlib.h>

// A linked List Node

struct Node {

int data;

struct Node\* next;

};

typedef struct Node node;

/\* A utility function to insert a

node at the beginning of

\* linked list \*/

void push(struct Node\*\* head\_ref, int new\_data)

{

/\* allocate node \*/

struct Node\* new\_node

= (struct Node\*)malloc(sizeof(struct Node));

/\* put in the data \*/

new\_node->data = new\_data;

/\* link the old list of the new node \*/

new\_node->next = (\*head\_ref);

/\* move the head to point to the new node \*/

(\*head\_ref) = new\_node;

}

/\* A utility function to print linked list \*/

void printList(struct Node\* node)

{

while (node != NULL) {

printf("%d ", node->data);

node = node->next;

}

printf("n");

}

// A utility function to swap two pointers

void swapPointer(Node\*\* a, Node\*\* b)

{

node\* t = \*a;

\*a = \*b;

\*b = t;

}

/\* A utility function to get size

of linked list \*/

int getSize(struct Node\* node)

{

int size = 0;

while (node != NULL) {

node = node->next;

size++;

}

return size;

}

// Adds two linked lists of same

// size represented by head1

// and head2 and returns head of

// the resultant linked list.

// Carry is propagated while

// returning from the recursion

node\* addSameSize(Node\* head1,

Node\* head2, int\* carry)

{

// Since the function assumes

// linked lists are of same

// size, check any of the two

// head pointers

if (head1 == NULL)

return NULL;

int sum;

// Allocate memory for sum

// node of current two nodes

Node\* result = (Node\*)malloc(sizeof(Node));

// Recursively add remaining nodes

// and get the carry

result->next

= addSameSize(head1->next,

head2->next, carry);

// add digits of current nodes

// and propagated carry

sum = head1->data + head2->data + \*carry;

\*carry = sum / 10;

sum = sum % 10;

// Assigne the sum to current

// node of resultant list

result->data = sum;

return result;

}

// This function is called after

// the smaller list is added

// to the bigger lists's sublist

// of same size. Once the

// right sublist is added, the

// carry must be added toe left

// side of larger list to get

// the final result.

void addCarryToRemaining(Node\* head1,

Node\* cur, int\* carry,

Node\*\* result)

{

int sum;

// If diff. number of nodes are

// not traversed, add carry

if (head1 != cur) {

addCarryToRemaining(head1->next,

cur, carry,

result);

sum = head1->data + \*carry;

\*carry = sum / 10;

sum %= 10;

// add this node to the front of the result

push(result, sum);

}

}

// The main function that adds two

// linked lists represented

// by head1 and head2. The sum of

// two lists is stored in a

// list referred by result

void addList(Node\* head1,

Node\* head2, Node\*\* result)

{

Node\* cur;

// first list is empty

if (head1 == NULL) {

\*result = head2;

return;

}

// second list is empty

else if (head2 == NULL)

{

\*result = head1;

return;

}

int size1 = getSize(head1);

int size2 = getSize(head2);

int carry = 0;

// Add same size lists

if (size1 == size2)

\*result = addSameSize(head1, head2, &carry);

else {

int diff = abs(size1 - size2);

// First list should always be

// larger than second

// list. If not, swap pointers

if (size1 < size2)

swapPointer(&head1, &head2);

// move diff. number of nodes in first list

for (cur = head1; diff--; cur = cur->next)

;

// get addition of same size lists

\*result = addSameSize(cur,

head2, &carry);

// get addition of remaining first list and carry

addCarryToRemaining(head1,

cur, &carry, result);

}

// if some carry is still there, add a new node to the

// front of the result list. e.g. 999 and 87

if (carry)

push(result, carry);

}

// Driver code

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

Node \*head1 = NULL, \*head2 = NULL, \*result = NULL;

int arr1[] = { 9, 9, 9 };

int arr2[] = { 1, 8 };

int size1 = sizeof(arr1) / sizeof(arr1[0]);

int size2 = sizeof(arr2) / sizeof(arr2[0]);

// Create first list as 9->9->9

int i;

for (i = size1 - 1; i >= 0; --i)

push(&head1, arr1[i]);

// Create second list as 1->8

for (i = size2 - 1; i >= 0; --i)

push(&head2, arr2[i]);

addList(head1, head2, &result);

printList(result);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

1 0 1 7 n

// Program to find out the substraction of two given link list

#include <stdbool.h>

#include <stdio.h>

#include <stdlib.h>

// A linked List Node

typedef struct Node {

int data;

struct Node\* next;

} Node;

// A utility which creates Node.

Node\* newNode(int data)

{

Node\* temp = (Node\*)malloc(sizeof(Node));

temp->data = data;

temp->next = NULL;

return temp;

}

/\* A utility function to get length

of linked list \*/

int getLength(Node\* Node)

{

int size = 0;

while (Node != NULL) {

Node = Node->next;

size++;

}

return size;

}

/\* A Utility that padds zeros in front of the

Node, with the given diff \*/

Node\* paddZeros(Node\* sNode, int diff)

{

if (sNode == NULL)

return NULL;

Node\* zHead = newNode(0);

diff--;

Node\* temp = zHead;

while (diff--) {

temp->next = newNode(0);

temp = temp->next;

}

temp->next = sNode;

return zHead;

}

/\* Subtract LinkedList Helper is a recursive function,

move till the last Node, and subtract the digits and

create the Node and return the Node. If d1 < d2, we

borrow the number from previous digit. \*/

static bool borrow;

Node\* subtractLinkedListHelper(Node\* l1, Node\* l2)

{

if (l1 == NULL && l2 == NULL && borrow == 0)

return NULL;

Node\* previous = subtractLinkedListHelper(

l1 ? l1->next : NULL, l2 ? l2->next : NULL);

int d1 = l1->data;

int d2 = l2->data;

int sub = 0;

/\* if you have given the value to next digit then

reduce the d1 by 1 \*/

if (borrow) {

d1--;

borrow = false;

}

/\* If d1 < d2, then borrow the number from previous

digit. Add 10 to d1 and set borrow = true; \*/

if (d1 < d2) {

borrow = true;

d1 = d1 + 10;

}

/\* subtract the digits \*/

sub = d1 - d2;

/\* Create a Node with sub value \*/

Node\* current = newNode(sub);

/\* Set the Next pointer as Previous \*/

current->next = previous;

return current;

}

/\* This API subtracts two linked lists and returns the

linked list which shall have the subtracted result. \*/

Node\* subtractLinkedList(Node\* l1, Node\* l2)

{

// Base Case.

if (l1 == NULL && l2 == NULL)

return NULL;

// In either of the case, get the lengths of both

// Linked list.

int len1 = getLength(l1);

int len2 = getLength(l2);

Node \*lNode = NULL, \*sNode = NULL;

Node\* temp1 = l1;

Node\* temp2 = l2;

// If lengths differ, calculate the smaller Node

// and padd zeros for smaller Node and ensure both

// larger Node and smaller Node has equal length.

if (len1 != len2) {

lNode = len1 > len2 ? l1 : l2;

sNode = len1 > len2 ? l2 : l1;

sNode = paddZeros(sNode, abs(len1 - len2));

}

else {

// If both list lengths are equal, then calculate

// the larger and smaller list. If 5-6-7 & 5-6-8

// are linked list, then walk through linked list

// at last Node as 7 < 8, larger Node is 5-6-8

// and smaller Node is 5-6-7.

while (l1 && l2) {

if (l1->data != l2->data) {

lNode = l1->data > l2->data ? temp1 : temp2;

sNode = l1->data > l2->data ? temp2 : temp1;

break;

}

l1 = l1->next;

l2 = l2->next;

}

}

// If both lNode and sNode still have NULL value,

// then this means that the value of both of the given

// linked lists is the same and hence we can directly

// return a node with value 0.

if (lNode == NULL && sNode == NULL) {

return newNode(0);

}

// After calculating larger and smaller Node, call

// subtractLinkedListHelper which returns the subtracted

// linked list.

borrow = false;

return subtractLinkedListHelper(lNode, sNode);

}

/\* A utility function to print linked list \*/

void printList(struct Node\* Node)

{

while (Node != NULL) {

printf("%d ", Node->data);

Node = Node->next;

}

printf("\n");

}

// Driver program to test above functions

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

Node\* head1 = newNode(1);

head1->next = newNode(0);

head1->next->next = newNode(0);

Node\* head2 = newNode(1);

Node\* result = subtractLinkedList(head1, head2);

printList(result);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

0 9 9

// Program for Polynomial Addition using Linked List

#include<stdio.h>

#include<stdlib.h>

struct Node {

int coeff;

int pow;

struct Node\* next;

};

// Function to create new node

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->coeff = x;

r->pow = y;

\*temp = r;

r->next = (struct Node\*)malloc(sizeof(struct Node));

r = r->next;

r->next = NULL;

}

else {

r->coeff = x;

r->pow = y;

r->next = (struct Node\*)malloc(sizeof(struct Node));

r = r->next;

r->next = NULL;

}

}

// Function Adding two polynomial numbers

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->coeff = poly1->coeff;

poly1 = poly1->next;

}

else if (poly1->pow < poly2->pow) {

poly->pow = poly2->pow;

poly->coeff = poly2->coeff;

poly2 = poly2->next;

}

else {

poly->pow = poly1->pow;

poly->coeff = poly1->coeff + poly2->coeff;

poly1 = poly1->next;

poly2 = poly2->next;

}

// Dynamically create new node

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->coeff = poly1->coeff;

poly1 = poly1->next;

}

if (poly2->next) {

poly->pow = poly2->pow;

poly->coeff = poly2->coeff;

poly2 = poly2->next;

}

poly->next

= (struct Node\*)malloc(sizeof(struct Node));

poly = poly->next;

poly->next = NULL;

}

}

// Display Linked list

void show(struct Node\* node)

{

while (node->next != NULL) {

printf("%dx^%d", node->coeff, node->pow);

node = node->next;

if (node->coeff >= 0) {

if (node->next != NULL)

printf("+");

}

}

}

// Driver code

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

struct Node \*poly1 = NULL, \*poly2 = NULL, \*poly = NULL;

// Create first list of 5x^2 + 4x^1 + 2x^0

create\_node(5, 2, &poly1);

create\_node(4, 1, &poly1);

create\_node(2, 0, &poly1);

// Create second list of -5x^1 - 5x^0

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));

// Function add two polynomial numbers

polyadd(poly1, poly2, poly);

// Display resultant List

printf("\nAdded polynomial: ");

show(poly);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

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

2nd Number: -5x^1-5x^0

Added polynomial: 5x^2-1x^1-3x^0

// Program for Polynomial Multiplication using Linked List

#include <stdio.h>

#include <stdlib.h>

typedef struct Node

{

// Define useful field of Node

int data;

int power;

struct Node \* next;

}Node;

Node \* getNode(int data, int power)

{

// Create dynamic memory of Node

Node \* ref = (Node \* ) malloc(sizeof(Node));

if (ref == NULL)

{

// Failed to create memory

return NULL;

}

ref->data = data;

ref->power = power;

ref->next = NULL;

return ref;

}

// Update node value

void updateRecord(Node \* ref, int data, int power)

{

ref->data = data;

ref->power = power;

}

typedef struct MultiplyPolynomial

{

// Define useful field of MultiplyPolynomial

struct Node \* head;

}MultiplyPolynomial;

MultiplyPolynomial \* getMultiplyPolynomial()

{

// Create dynamic memory of MultiplyPolynomial

MultiplyPolynomial \* ref = (MultiplyPolynomial \* )

malloc(sizeof(MultiplyPolynomial));

if (ref == NULL)

{

// Failed to create memory

return NULL;

}

ref->head = NULL;

return ref;

}

// Insert Node element

void insert(MultiplyPolynomial \* ref, int data, int power)

{

if (ref->head == NULL)

{

// Add first node

ref->head = getNode(data, power);

}

else

{

Node \* node = NULL;

Node \* temp = ref->head;

Node \* location = NULL;

// Find the valid new node location

while (temp != NULL && temp->power >= power)

{

location = temp;

temp = temp->next;

}

if (location != NULL && location->power == power)

{

// When polynomial power already exists

// Then add current add to previous data

location->data = location->data + data;

}

else

{

node = getNode(data, power);

if (location == NULL)

{

// When add node in begining

node->next = ref->head;

ref->head = node;

}

else

{

// When adding node in intermediate

// location or end location

node->next = location->next;

location->next = node;

}

}

}

}

// Perform multiplication of given polynomial

MultiplyPolynomial \* multiplyPolynomials(

MultiplyPolynomial \* ref, MultiplyPolynomial \* other)

{

// Define some useful variable

MultiplyPolynomial \* result = getMultiplyPolynomial();

// Get first node of polynomial

Node \* poly1 = ref->head;

Node \* temp = other->head;

int power\_value = 0;

int coefficient = 0;

// Execute loop until when polynomial are exist

while (poly1 != NULL)

{

temp = other->head;

while (temp != NULL)

{

// Get result info

power\_value = poly1->power + temp->power;

coefficient = poly1->data \* temp->data;

insert(result, coefficient, power\_value);

// Visit to next node

temp = temp->next;

}

// Visit to next node

poly1 = poly1->next;

}

// return first node

return result;

}

// Display given polynomial nodes

void display(MultiplyPolynomial \* ref)

{

if (ref->head == NULL)

{

printf("Empty Polynomial ");

}

printf(" ");

Node \* temp = ref->head;

while (temp != NULL)

{

if (temp != ref->head)

{

printf(" + %d", temp->data);

}

else

{

printf("%d",temp->data);

}

if (temp->power != 0)

{

printf("x^%d", temp->power);

}

// Visit to next node

temp = temp->next;

}

printf("\n");

}

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

MultiplyPolynomial \* a = getMultiplyPolynomial();

MultiplyPolynomial \* b = getMultiplyPolynomial();

// Add node in polynomial A

insert(a, 9, 3);

insert(a, 4, 2);

insert(a, 3, 0);

insert(a, 7, 1);

insert(a, 3, 4);

// Add node in polynomial b

insert(b, 7, 3);

insert(b, 4, 0);

insert(b, 6, 1);

insert(b, 1, 2);

// Display Polynomial nodes

printf("\n Polynomial A\n");

display(a);

printf(" Polynomial B\n");

display(b);

MultiplyPolynomial \* result = multiplyPolynomials(a, b);

// Display calculated result

printf(" Result\n");

display(result);

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Polynomial A

3x^4 + 9x^3 + 4x^2 + 7x^1 + 3

Polynomial B

7x^3 + 1x^2 + 6x^1 + 4

Result

21x^7 + 66x^6 + 55x^5 + 119x^4 + 88x^3 + 61x^2 + 46x^1 + 12

**LAB – 23**

// Program for Circular Linked List Primitive Operations

#include<stdio.h>

#include<stdlib.h>

struct Node {

int coeff;

int pow;

struct Node\* next;

};

// Function to create new node

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->coeff = x;

r->pow = y;

\*temp = r;

r->next = (struct Node\*)malloc(sizeof(struct Node));

r = r->next;

r->next = NULL;

}

else {

r->coeff = x;

r->pow = y;

r->next = (struct Node\*)malloc(sizeof(struct Node));

r = r->next;

r->next = NULL;

}

}

// Function Adding two polynomial numbers

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->coeff = poly1->coeff;

poly1 = poly1->next;

}

else if (poly1->pow < poly2->pow) {

poly->pow = poly2->pow;

poly->coeff = poly2->coeff;

poly2 = poly2->next;

}

else {

poly->pow = poly1->pow;

poly->coeff = poly1->coeff + poly2->coeff;

poly1 = poly1->next;

poly2 = poly2->next;

}

// Dynamically create new node

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->coeff = poly1->coeff;

poly1 = poly1->next;

}

if (poly2->next) {

poly->pow = poly2->pow;

poly->coeff = poly2->coeff;

poly2 = poly2->next;

}

poly->next

= (struct Node\*)malloc(sizeof(struct Node));

poly = poly->next;

poly->next = NULL;

}

}

// Display Linked list

void show(struct Node\* node)

{

while (node->next != NULL) {

printf("%dx^%d", node->coeff, node->pow);

node = node->next;

if (node->coeff >= 0) {

if (node->next != NULL)

printf("+");

}

}

}

// Driver code

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

struct Node \*poly1 = NULL, \*poly2 = NULL, \*poly = NULL;

// Create first list of 5x^2 + 4x^1 + 2x^0

create\_node(5, 2, &poly1);

create\_node(4, 1, &poly1);

create\_node(2, 0, &poly1);

// Create second list of -5x^1 - 5x^0

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));

// Function add two polynomial numbers

polyadd(poly1, poly2, poly);

// Display resultant List

printf("\nAdded polynomial: ");

show(poly);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

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

2nd Number: -5x^1-5x^0

Added polynomial: 5x^2-1x^1-3x^0

// Program for concatenation of Circular Linked List

#include<stdio.h>

#include<stdlib.h>

struct node

{

int info;

struct node \*link;

};

struct node \*create\_list(struct node \*last);

void display(struct node \*last);

struct node \*addtoempty(struct node \*last,int data );

struct node \*addatend(struct node \*last,int data);

struct node \*concat(struct node \*last1,struct node \*last2);

int main( )

{

printf("ARYAN ARORA CS-A 2100320120032\n");

struct node \*last1=NULL,\*last2=NULL;

last1=create\_list(last1);

last2=create\_list(last2);

printf("First list is : ");

display(last1);

printf("Second list is : ");

display(last2);

last1=concat(last1, last2);

printf("Concatenated list is : ");

display(last1);

return 0;

}

struct node \*concat( struct node \*last1,struct node \*last2)

{

struct node \*ptr;

if(last1==NULL)

{

last1=last2;

return last1;

}

if(last2==NULL )

return last1;

ptr=last1->link;

last1->link=last2->link;

last2->link=ptr;

last1=last2;

return last1;

}

struct node \*create\_list(struct node \*last)

{

int i,n;

int data;

printf("Enter the number of nodes : ");

scanf("%d",&n);

last=NULL;

if(n==0)

return last;

printf("Enter the element to be inserted : ");

scanf("%d",&data);

last=addtoempty(last,data);

for(i=2;i<=n;i++)

{

printf("Enter the element to be inserted : ");

scanf("%d",&data);

last=addatend(last,data);

}

return last;

}

void display(struct node \*last)

{

struct node \*p;

if(last==NULL)

{

printf("List is empty\n");

return;

}

p=last->link; /\*p points to first node\*/

do

{

printf("%d ", p->info);

p=p->link;

}while(p!=last->link);

printf("\n");

}

struct node \*addtoempty(struct node \*last,int data)

{

struct node \*tmp;

tmp = (struct node \*)malloc(sizeof(struct node));

tmp->info = data;

last = tmp;

last->link = last;

return last;

}

struct node \*addatend(struct node \*last,int data)

{

struct node \*tmp;

tmp = (struct node \*)malloc(sizeof(struct node));

tmp->info = data;

tmp->link = last->link;

last->link = tmp;

last = tmp;

return last;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Enter the number of nodes : 2

Enter the element to be inserted : 4

Enter the element to be inserted : 2

Enter the number of nodes : 5

Enter the element to be inserted : 3

Enter the element to be inserted : 2

Enter the element to be inserted : 2

Enter the element to be inserted : 5

Enter the element to be inserted :

6

First list is : 4 2

Second list is : 3 2 2 5 6

Concatenated list is : 4 2 3 2 2 5 6

// Program for implementation of Josephus Problem

#include <stdio.h>

#include <stdlib.h>

struct node

{

int num;

struct node \*next;

};

void create(struct node \*\*);

void display(struct node \*);

int survivor(struct node \*\*, int);

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

struct node \*head = NULL;

int survive, skip;

create(&head);

printf("The persons in circular list are:\n");

display(head);

printf("Enter the number of persons to be skipped: ");

scanf("%d", &skip);

survive = survivor(&head, skip);

printf("The person to survive is : %d\n", survive);

free(head);

return 0;

}

int survivor(struct node \*\*head, int k)

{

struct node \*p, \*q;

int i;

q = p = \*head;

while (p->next != p)

{

for (i = 0; i < k - 1; i++)

{

q = p;

p = p->next;

}

q->next = p->next;

printf("%d has been killed.\n", p->num);

free(p);

p = q->next;

}

\*head = p;

return (p->num);

}

void create (struct node \*\*head)

{

struct node \*temp, \*rear;

int a, ch;

do

{

printf("Enter a number: ");

scanf("%d", &a);

temp = (struct node \*)malloc(sizeof(struct node));

temp->num = a;

temp->next = NULL;

if (\*head == NULL)

{

\*head = temp;

}

else

{

rear->next = temp;

}

rear = temp;

printf("Do you want to add a number [1/0]? ");

scanf("%d", &ch);

} while (ch != 0);

rear->next = \*head;

}

void display(struct node \*head)

{

struct node \*temp;

temp = head;

printf("%d ", temp->num);

temp = temp->next;

while (head != temp)

{

printf("%d ", temp->num);

temp = temp->next;

}

printf("\n");

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Enter a number: 4

Do you want to add a number [1/0]? 1

Enter a number: 6

Do you want to add a number [1/0]? 1

Enter a number: 8

Do you want to add a number [1/0]? 1

Enter a number: 7

Do you want to add a number [1/0]? 1

Enter a number: 5

Do you want to add a number [1/0]? 1

Enter a number: 5

Do you want to add a number [1/0]? 1

Enter a number: 5

Do you want to add a number [1/0]? 1

Enter a number: 6

Do you want to add a number [1/0]? 1

Enter a number: 6

Do you want to add a number [1/0]? 0

The persons in circular list are:

4 6 8 7 5 5 5 6 6

Enter the number of persons to be skipped: 2

6 has been killed.

7 has been killed.

5 has been killed.

6 has been killed.

4 has been killed.

5 has been killed.

6 has been killed.

5 has been killed.

The person to survive is : 8

**LAB – 24**

// Program for Doubly linked list Primitive operations

#include <stdio.h>

#include <stdlib.h>

// Linked List Node

struct node {

int info;

struct node \*prev, \*next;

};

struct node\* start = NULL;

// Function to traverse the linked list

void traverse()

{

// List is empty

if (start == NULL) {

printf("\nList is empty\n");

return;

}

// Else print the Data

struct node\* temp;

temp = start;

while (temp != NULL) {

printf("Data = %d\n", temp->info);

temp = temp->next;

}

}

// Function to insert at the front

// of the linked list

void insertAtFront()

{

int data;

struct node\* temp;

temp = (struct node\*)malloc(sizeof(struct node));

printf("\nEnter number to be inserted: ");

scanf("%d", &data);

temp->info = data;

temp->prev = NULL;

// Pointer of temp will be

// assigned to start

temp->next = start;

start = temp;

}

// Function to insert at the end of

// the linked list

void insertAtEnd()

{

int data;

struct node \*temp, \*trav;

temp = (struct node\*)malloc(sizeof(struct node));

temp->prev = NULL;

temp->next = NULL;

printf("\nEnter number to be inserted: ");

scanf("%d", &data);

temp->info = data;

temp->next = NULL;

trav = start;

// If start is NULL

if (start == NULL) {

start = temp;

}

// Changes Links

else {

while (trav->next != NULL)

trav = trav->next;

temp->prev = trav;

trav->next = temp;

}

}

// Function to insert at any specified

// position in the linked list

void insertAtPosition()

{

int data, pos, i = 1;

struct node \*temp, \*newnode;

newnode = malloc(sizeof(struct node));

newnode->next = NULL;

newnode->prev = NULL;

// Enter the position and data

printf("\nEnter position : ");

scanf("%d", &pos);

// If start==NULL,

if (start == NULL) {

start = newnode;

newnode->prev = NULL;

newnode->next = NULL;

}

// If position==1,

else if (pos == 1) {

// this is author method its correct but we can simply call insertAtfront() function for this special case

/\* newnode->next = start;

newnode->next->prev = newnode;

newnode->prev = NULL;

start = newnode; \*/

// now this is improved by Jay Ghughriwala on geeksforgeeks

insertAtFront();

}

// Change links

else {

printf("\nEnter number to be inserted: ");

scanf("%d", &data);

newnode->info = data;

temp = start;

while (i < pos - 1) {

temp = temp->next;

i++;

}

newnode->next = temp->next;

newnode->prev = temp;

temp->next = newnode;

temp->next->prev = newnode;

}

}

// Function to delete from the front

// of the linked list

void deleteFirst()

{

struct node\* temp;

if (start == NULL)

printf("\nList is empty\n");

else {

temp = start;

start = start->next;

if (start != NULL)

start->prev = NULL;

free(temp);

}

}

// Function to delete from the end

// of the linked list

void deleteEnd()

{

struct node\* temp;

if (start == NULL)

printf("\nList is empty\n");

temp = start;

while (temp->next != NULL)

temp = temp->next;

if (start->next == NULL)

start = NULL;

else {

temp->prev->next = NULL;

free(temp);

}

}

// Function to delete from any specified

// position from the linked list

void deletePosition()

{

int pos, i = 1;

struct node \*temp, \*position;

temp = start;

// If DLL is empty

if (start == NULL)

printf("\nList is empty\n");

// Otherwise

else {

// Position to be deleted

printf("\nEnter position : ");

scanf("%d", &pos);

// If the position is the first node

if (pos == 1) {

deleteFirst(); // im,proved by Jay Ghughriwala on GeeksforGeeks

if (start != NULL) {

start->prev = NULL;

}

free(position);

return;

}

// Traverse till position

while (i < pos - 1) {

temp = temp->next;

i++;

}

// Change Links

position = temp->next;

if (position->next != NULL)

position->next->prev = temp;

temp->next = position->next;

// Free memory

free(position);

}

}

// Driver Code

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int choice;

while (1) {

printf("\n\t1 To see list\n");

printf("\t2 For insertion at"

" starting\n");

printf("\t3 For insertion at"

" end\n");

printf("\t4 For insertion at "

"any position\n");

printf("\t5 For deletion of "

"first element\n");

printf("\t6 For deletion of "

"last element\n");

printf("\t7 For deletion of "

"element at any position\n");

printf("\t8 To exit\n");

printf("\nEnter Choice :\n");

scanf("%d", &choice);

switch (choice) {

case 1:

traverse();

break;

case 2:

insertAtFront();

break;

case 3:

insertAtEnd();

break;

case 4:

insertAtPosition();

break;

case 5:

deleteFirst();

break;

case 6:

deleteEnd();

break;

case 7:

deletePosition();

break;

case 8:

exit(1);

break;

default:

printf("Incorrect Choice. Try Again \n");

continue;

}

}

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

1 To see list

2 For insertion at starting

3 For insertion at end

4 For insertion at any position

5 For deletion of first element

6 For deletion of last element

7 For deletion of element at any position

8 To exit

Enter Choice :

1

List is empty

1 To see list

2 For insertion at starting

3 For insertion at end

4 For insertion at any position

5 For deletion of first element

6 For deletion of last element

7 For deletion of element at any position

8 To exit

Enter Choice :

2

Enter number to be inserted: 2

1 To see list

2 For insertion at starting

3 For insertion at end

4 For insertion at any position

5 For deletion of first element

6 For deletion of last element

7 For deletion of element at any position

8 To exit

Enter Choice :

1

Data = 2

1 To see list

2 For insertion at starting

3 For insertion at end

4 For insertion at any position

5 For deletion of first element

6 For deletion of last element

7 For deletion of element at any position

8 To exit

Enter Choice : 8

// Program for Circular Doubly Linked List Primitive Operations

#include<stdio.h>

#include<stdlib.h>

struct node

{

struct node \*prev;

struct node \*next;

int data;

};

struct node \*head;

void insertion\_beginning();

void insertion\_last();

void deletion\_beginning();

void deletion\_last();

void display();

void search();

int main ()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int choice =0;

while(choice != 9)

{

printf("\n\*\*\*\*\*\*\*\*\*Main Menu\*\*\*\*\*\*\*\*\*\n");

printf("\nChoose one option from the following list ...\n");

printf("\n===============================================\n");

printf("\n1.Insert in Beginning\n2.Insert at last\n3.Delete from Beginning\n4.Delete from last\n5.Search\n6.Show\n7.Exit\n");

printf("\nEnter your choice?\n");

scanf("\n%d",&choice);

switch(choice)

{

case 1:

insertion\_beginning();

break;

case 2:

insertion\_last();

break;

case 3:

deletion\_beginning();

break;

case 4:

deletion\_last();

break;

case 5:

search();

break;

case 6:

display();

break;

case 7:

exit(0);

break;

default:

printf("Please enter valid choice..");

}

}

return 0;

}

void insertion\_beginning()

{

struct node \*ptr,\*temp;

int item;

ptr = (struct node \*)malloc(sizeof(struct node));

if(ptr == NULL)

{

printf("\nOVERFLOW");

}

else

{

printf("\nEnter Item value");

scanf("%d",&item);

ptr->data=item;

if(head==NULL)

{

head = ptr;

ptr -> next = head;

ptr -> prev = head;

}

else

{

temp = head;

while(temp -> next != head)

{

temp = temp -> next;

}

temp -> next = ptr;

ptr -> prev = temp;

head -> prev = ptr;

ptr -> next = head;

head = ptr;

}

printf("\nNode inserted\n");

}

}

void insertion\_last()

{

struct node \*ptr,\*temp;

int item;

ptr = (struct node \*) malloc(sizeof(struct node));

if(ptr == NULL)

{

printf("\nOVERFLOW");

}

else

{

printf("\nEnter value");

scanf("%d",&item);

ptr->data=item;

if(head == NULL)

{

head = ptr;

ptr -> next = head;

ptr -> prev = head;

}

else

{

temp = head;

while(temp->next !=head)

{

temp = temp->next;

}

temp->next = ptr;

ptr ->prev=temp;

head -> prev = ptr;

ptr -> next = head;

}

}

printf("\nnode inserted\n");

}

void deletion\_beginning()

{

struct node \*temp;

if(head == NULL)

{

printf("\n UNDERFLOW");

}

else if(head->next == head)

{

head = NULL;

free(head);

printf("\nnode 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;

}

}

void deletion\_last()

{

struct node \*ptr;

if(head == NULL)

{

printf("\n UNDERFLOW");

}

else if(head->next == head)

{

head = NULL;

free(head);

printf("\nnode deleted\n");

}

else

{

ptr = head;

if(ptr->next != head)

{

ptr = ptr -> next;

}

ptr -> prev -> next = head;

head -> prev = ptr -> prev;

free(ptr);

printf("\nnode deleted\n");

}

}

void display()

{

struct node \*ptr;

ptr=head;

if(head == NULL)

{

printf("\nnothing to print");

}

else

{

printf("\n printing values ... \n");

while(ptr -> next != head)

{

printf("%d\n", ptr -> data);

ptr = ptr -> next;

}

printf("%d\n", ptr -> data);

}

}

void search()

{

struct node \*ptr;

int item,i=0,flag=1;

ptr = head;

if(ptr == NULL)

{

printf("\nEmpty List\n");

}

else

{

printf("\nEnter item which you want to search?\n");

scanf("%d",&item);

if(head ->data == item)

{

printf("item found at location %d",i+1);

flag=0;

}

else

{

while (ptr->next != head)

{

if(ptr->data == item)

{

printf("item found at location %d ",i+1);

flag=0;

break;

}

else

{

flag=1;

}

i++;

ptr = ptr -> next;

}

}

if(flag != 0)

{

printf("Item not found\n");

}

}

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

\*\*\*\*\*\*\*\*\*Main Menu\*\*\*\*\*\*\*\*\*

Choose one option from the following list ...

===============================================

1.Insert in Beginning

2.Insert at last

3.Delete from Beginning

4.Delete from last

5.Search

6.Show

7.Exit

Enter your choice?

1

Enter Item value5

Node inserted

\*\*\*\*\*\*\*\*\*Main Menu\*\*\*\*\*\*\*\*\*

Choose one option from the following list ...

===============================================

1.Insert in Beginning

2.Insert at last

3.Delete from Beginning

4.Delete from last

5.Search

6.Show

7.Exit

Enter your choice?

1

Enter Item value6

Node inserted

\*\*\*\*\*\*\*\*\*Main Menu\*\*\*\*\*\*\*\*\*

Choose one option from the following list ...

===============================================

1.Insert in Beginning

2.Insert at last

3.Delete from Beginning

4.Delete from last

5.Search

6.Show

7.Exit

Enter your choice?

1

Enter Item value

8

Node inserted

\*\*\*\*\*\*\*\*\*Main Menu\*\*\*\*\*\*\*\*\*

Choose one option from the following list ...

===============================================

1.Insert in Beginning

2.Insert at last

3.Delete from Beginning

4.Delete from last

5.Search

6.Show

7.Exit

Enter your choice?

6

printing values ...

8

6

5

\*\*\*\*\*\*\*\*\*Main Menu\*\*\*\*\*\*\*\*\*

Choose one option from the following list ...

===============================================

1.Insert in Beginning

2.Insert at last

3.Delete from Beginning

4.Delete from last

5.Search

6.Show

7.Exit

Enter your choice?

7

// Program for Linked List Implementation of Stacks

#include <stdio.h>

#include <stdlib.h>

void push();

void pop();

void display();

struct node

{

int val;

struct node \*next;

};

struct node \*head;

int main ()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int choice=0;

printf("\n\*\*\*\*\*\*\*\*\*Stack operations using linked list\*\*\*\*\*\*\*\*\*\n");

printf("\n----------------------------------------------\n");

while(choice != 4)

{

printf("\n\nChose one from the below options...\n");

printf("\n1.Push\n2.Pop\n3.Show\n4.Exit");

printf("\n Enter your choice \n");

scanf("%d",&choice);

switch(choice)

{

case 1:

{

push();

break;

}

case 2:

{

pop();

break;

}

case 3:

{

display();

break;

}

case 4:

{

printf("Exiting....");

break;

}

default:

{

printf("Please Enter valid choice ");

}

};

}

return 0;

}

void push ()

{

int val;

struct node \*ptr = (struct node\*)malloc(sizeof(struct node));

if(ptr == NULL)

{

printf("not able to push the element");

}

else

{

printf("Enter the value");

scanf("%d",&val);

if(head==NULL)

{

ptr->val = val;

ptr -> next = NULL;

head=ptr;

}

else

{

ptr->val = val;

ptr->next = head;

head=ptr;

}

printf("Item pushed");

}

}

void pop()

{

int item;

struct node \*ptr;

if (head == NULL)

{

printf("Underflow");

}

else

{

item = head->val;

ptr = head;

head = head->next;

free(ptr);

printf("Item popped");

}

}

void display()

{

int i;

struct node \*ptr;

ptr=head;

if(ptr == NULL)

{

printf("Stack is empty\n");

}

else

{

printf("Printing Stack elements \n");

while(ptr!=NULL)

{

printf("%d\n",ptr->val);

ptr = ptr->next;

}

}

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

\*\*\*\*\*\*\*\*\*Stack operations using linked list\*\*\*\*\*\*\*\*\*

----------------------------------------------

Chose one from the below options...

1.Push

2.Pop

3.Show

4.Exit

Enter your choice

1

Enter the value3

Item pushed

Chose one from the below options...

1.Push

2.Pop

3.Show

4.Exit

Enter your choice

1

Enter the value6

Item pushed

Chose one from the below options...

1.Push

2.Pop

3.Show

4.Exit

Enter your choice

3

Printing Stack elements

6

3

Chose one from the below options...

1.Push

2.Pop

3.Show

4.Exit

Enter your choice

4

Exiting....

// Program for Linked List Implementaion of Queue

#include <stdio.h>

#include <stdlib.h>

// A linked list (LL) node to store a queue entry

struct QNode {

int key;

struct QNode\* next;

};

// The queue, front stores the front node of LL and rear

// stores the last node of LL

struct Queue {

struct QNode \*front, \*rear;

};

// A utility function to create a new linked list node.

struct QNode\* newNode(int k)

{

struct QNode\* temp

= (struct QNode\*)malloc(sizeof(struct QNode));

temp->key = k;

temp->next = NULL;

return temp;

}

// A utility function to create an empty queue

struct Queue\* createQueue()

{

struct Queue\* q

= (struct Queue\*)malloc(sizeof(struct Queue));

q->front = q->rear = NULL;

return q;

}

// The function to add a key k to q

void enQueue(struct Queue\* q, int k)

{

// Create a new LL node

struct QNode\* temp = newNode(k);

// If queue is empty, then new node is front and rear

// both

if (q->rear == NULL) {

q->front = q->rear = temp;

return;

}

// Add the new node at the end of queue and change rear

q->rear->next = temp;

q->rear = temp;

}

// Function to remove a key from given queue q

void deQueue(struct Queue\* q)

{

// If queue is empty, return NULL.

if (q->front == NULL)

return;

// Store previous front and move front one node ahead

struct QNode\* temp = q->front;

q->front = q->front->next;

// If front becomes NULL, then change rear also as NULL

if (q->front == NULL)

q->rear = NULL;

free(temp);

}

// Driver code

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

struct Queue\* q = createQueue();

enQueue(q, 10);

enQueue(q, 20);

deQueue(q);

deQueue(q);

enQueue(q, 30);

enQueue(q, 40);

enQueue(q, 50);

deQueue(q);

printf("Queue Front : %d \n", ((q->front != NULL) ? (q->front)->key : -1));

printf("Queue Rear : %d", ((q->rear != NULL) ? (q->rear)->key : -1));

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Queue Front : 40

Queue Rear : 50

// Program for Linked List implementation of Double Ended Queue

#include <stdio.h>

#include <stdlib.h>

struct node {

int data;

struct node \*prev, \*next;

};

struct node \*head = NULL, \*tail = NULL;

struct node \* createNode(int data) {

struct node \*newnode = (struct node \*)malloc(sizeof (struct node));

newnode->data = data;

newnode->next = newnode->prev = NULL;

return (newnode);

}

/\*

\* create sentinel(dummy head & tail) that

\* helps us to do insertion and deletion

\* operation at front and rear so easily. And

\* these dummy head and tail wont get deleted

\* till the end of execution of this program

\*/

void createSentinels() {

head = createNode(0);

tail = createNode(0);

head->next = tail;

tail->prev = head;

}

/\* insertion at the front of the queue \*/

void enqueueAtFront(int data) {

struct node \*newnode, \*temp;

newnode = createNode(data);

temp = head->next;

head->next = newnode;

newnode->prev = head;

newnode->next = temp;

temp->prev = newnode;

}

/\*insertion at the rear of the queue \*/

void enqueueAtRear(int data) {

struct node \*newnode, \*temp;

newnode = createNode(data);

temp = tail->prev;

tail->prev = newnode;

newnode->next = tail;

newnode->prev = temp;

temp->next = newnode;

}

/\* deletion at the front of the queue \*/

void dequeueAtFront() {

struct node \*temp;

if (head->next == tail) {

printf("Queue is empty\n");

} else {

temp = head->next;

head->next = temp->next;

temp->next->prev = head;

free(temp);

}

return;

}

/\* deletion at the rear of the queue \*/

void dequeueAtRear() {

struct node \*temp;

if (tail->prev == head) {

printf("Queue is empty\n");

} else {

temp = tail->prev;

tail->prev = temp->prev;

temp->prev->next = tail;

free(temp);

}

return;

}

/\* display elements present in the queue \*/

void display() {

struct node \*temp;

if (head->next == tail) {

printf("Queue is empty\n");

return;

}

temp = head->next;

while (temp != tail) {

printf("%-3d", temp->data);

temp = temp->next;

}

printf("\n");

}

int main() {

printf("ARYAN ARORA CS-A 2100320120032\n");

int data, ch;

createSentinels();

while (1) {

printf("1. Enqueue at front\n2. Enqueue at rear\n");

printf("3. Dequeue at front\n4. Dequeue at rear\n");

printf("5. Display\n6. Exit\n");

printf("Enter your choice:");

scanf("%d", &ch);

switch (ch) {

case 1:

printf("Enter the data to insert:");

scanf("%d", &data);

enqueueAtFront(data);

break;

case 2:

printf("Enter ur data to insert:");

scanf("%d", &data);

enqueueAtRear(data);

break;

case 3:

dequeueAtFront();

break;

case 4:

dequeueAtRear();

break;

case 5:

display();

break;

case 6:

exit(0);

default:

printf("Pls. enter correct option\n");

break;

}

}

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

1. Enqueue at front

2. Enqueue at rear

3. Dequeue at front

4. Dequeue at rear

5. Display

6. Exit

Enter your choice:1

Enter the data to insert:3

1. Enqueue at front

2. Enqueue at rear

3. Dequeue at front

4. Dequeue at rear

5. Display

6. Exit

Enter your choice:1

Enter the data to insert:5

1. Enqueue at front

2. Enqueue at rear

3. Dequeue at front

4. Dequeue at rear

5. Display

6. Exit

Enter your choice:5

5 3

1. Enqueue at front

2. Enqueue at rear

3. Dequeue at front

4. Dequeue at rear

5. Display

6. Exit

Enter your choice:6

**LAB – 25**

// Program for Pre-Order, In-Order, Post-Order Traversal

#include <stdio.h>

#include <stdlib.h>

/\* A binary tree node has data, pointer to left child

and a pointer to right child \*/

struct node {

int data;

struct node\* left;

struct node\* right;

};

/\* Helper function that allocates a new node with the

given data and NULL left and right pointers. \*/

struct node\* newNode(int data)

{

struct node\* node

= (struct node\*)malloc(sizeof(struct node));

node->data = data;

node->left = NULL;

node->right = NULL;

return (node);

}

/\* Given a binary tree, print its nodes in inorder\*/

void printInorder(struct node\* node)

{

if (node == NULL)

return;

/\* first recur on left child \*/

printInorder(node->left);

/\* then print the data of node \*/

printf("%d ", node->data);

/\* now recur on right child \*/

printInorder(node->right);

}

/\* Driver code\*/

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

struct node\* root = newNode(1);

root->left = newNode(2);

root->right = newNode(3);

root->left->left = newNode(4);

root->left->right = newNode(5);

// Function call

printf("\nInorder traversal of binary tree is \n");

printInorder(root);

getchar();

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Inorder traversal of binary tree is

4 2 5 1 3

// Recursive Creation of Binary Tree

#include<stdio.h>

typedef struct node

{

int data;

struct node \*left;

struct node \*right;

} node;

node \*create()

{

node \*p;

int x;

printf("Enter data(-1 for no data):");

scanf("%d",&x);

if(x==-1)

return NULL;

p=(node\*)malloc(sizeof(node));

p->data=x;

printf("Enter left child of %d:\n",x);

p->left=create();

printf("Enter right child of %d:\n",x);

p->right=create();

return p;

}

void preorder(node \*t) //address of root node is passed in t

{

if(t!=NULL)

{

printf("\n%d",t->data); //visit the root

preorder(t->left); //preorder traversal on left subtree

preorder(t->right); //preorder traversal om right subtree

}

}

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

node \*root;

root=create();

printf("\nThe preorder traversal of tree is:\n");

preorder(root);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Enter data(-1 for no data):2

Enter left child of 2:

Enter data(-1 for no data):3

Enter left child of 3:

Enter data(-1 for no data):6

Enter left child of 6:

Enter data(-1 for no data):7

Enter left child of 7:

Enter data(-1 for no data):8

Enter left child of 8:

Enter data(-1 for no data):8

Enter left child of 8:

Enter data(-1 for no data):5

Enter left child of 5:

Enter data(-1 for no data):2

Enter left child of 2:

Enter data(-1 for no data):12

Enter left child of 12:

Enter data(-1 for no data):34

Enter left child of 34:

Enter data(-1 for no data):45

Enter left child of 45:

Enter data(-1 for no data):67

Enter left child of 67:

Enter data(-1 for no data):89

Enter left child of 89:

Enter data(-1 for no data):90

Enter left child of 90:

Enter data(-1 for no data):-1

Enter right child of 90:

Enter data(-1 for no data):34

Enter left child of 34:

Enter data(-1 for no data):23

Enter left child of 23:

Enter data(-1 for no data):23

4Enter left child of 23:

Enter data(-1 for no data):5

6Enter left child of 5:

Enter data(-1 for no data):7

Enter left child of 7:

Enter data(-1 for no data):23

Enter left child of 23:

Enter data(-1 for no data):90

Enter left child of 90:

Enter data(-1 for no data):

34

Enter left child of 4:

Enter data(-1 for no data):23

Enter left child of 23:

Enter data(-1 for no data):12

Enter left child of 12:

Enter data(-1 for no data):35

// Program to find Node Count in the Binary Tree

#include <stdio.h>

#include <stdlib.h>

struct node

{

int info;

struct node \*left, \*right;

};

struct node \*createnode(int key)

{

struct node \*newnode = (struct node\*)malloc(sizeof(struct node));

newnode->info = key;

newnode->left = NULL;

newnode->right = NULL;

return(newnode);

}

static int count = 0;

int countnodes(struct node \*root)

{

if(root != NULL)

{

countnodes(root->left);

count++;

countnodes(root->right);

}

return count;

}

/\*

\* Main Function

\*/

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

/\* Creating first Tree. \*/

struct node \*newnode = createnode(25);

newnode->left = createnode(27);

newnode->right = createnode(19);

newnode->left->left = createnode(17);

newnode->left->right = createnode(91);

newnode->right->left = createnode(13);

newnode->right->right = createnode(55);

/\* Sample Tree 1:

\* 25

\* / \

\* 27 19

\* / \ / \

\* 17 91 13 55

\*/

printf("Number of nodes in tree 1 = %d ",countnodes(newnode));

printf("\n");

count = 0;

/\* Creating second Tree. \*/

struct node \*node = createnode(1);

node->right = createnode(2);

node->right->right = createnode(3);

node->right->right->right = createnode(4);

node->right->right->right->right = createnode(5);

/\* Sample Tree 2: Right Skewed Tree (Unbalanced).

\* 1

\* \

\* 2

\* \

\* 3

\* \

\* 4

\* \

\* 5

\*/

printf("Number of nodes in tree 2 = %d ",countnodes(node));

printf("\n");

count = 0;

/\* Creating third Tree. \*/

struct node \*root = createnode(15);

/\* Sample Tree 3- Tree having just one root node.

\* 15

\*/

printf("Number of nodes in tree 3 = %d",countnodes(root));

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Number of nodes in tree 1 = 7

Number of nodes in tree 2 = 5

Number of nodes in tree 3 = 1

// Program to find count of nodes having 1 child, 2 children and leaf nodes

#include <stdio.h>

#include <stdlib.h>

/\* A binary tree node has data, pointer to left child

and a pointer to right child \*/

struct node

{

int data;

struct node\* left;

struct node\* right;

};

/\* Function to get the count of leaf nodes in a binary tree\*/

unsigned int getLeafCount(struct node\* node)

{

if(node == NULL)

return 0;

if(node->left == NULL && node->right==NULL)

return 1;

else

return getLeafCount(node->left)+

getLeafCount(node->right);

}

/\* Helper function that allocates a new node with the

given data and NULL left and right pointers. \*/

struct node\* newNode(int data)

{

struct node\* node = (struct node\*)

malloc(sizeof(struct node));

node->data = data;

node->left = NULL;

node->right = NULL;

return(node);

}

/\*Driver program to test above functions\*/

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

/\*create a tree\*/

struct node \*root = newNode(1);

root->left = newNode(2);

root->right = newNode(3);

root->left->left = newNode(4);

root->left->right = newNode(5);

/\*get leaf count of the above created tree\*/

printf("Leaf count of the tree is %d", getLeafCount(root));

getchar();

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Leaf count of the tree is 3

// Program to Find the height of the Binary Tree

#include <stdio.h>

#include <stdlib.h>

struct node {

int data;

struct node\* left;

struct node\* right;

};

int height(struct node\* node)

{

if (node == NULL)

return 0;

else {

int leftHeight = height(node->left);

int rightHeight = height(node->right);

if (leftHeight > rightHeight)

return (leftHeight + 1);

else

return (rightHeight + 1);

}

}

struct node\* newNode(int data)

{

struct node\* node

= (struct node\*)malloc(sizeof(struct node));

node->data = data;

node->left = NULL;

node->right = NULL;

return (node);

}

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

struct node\* root = newNode(10);

root->left = newNode(20);

root->right = newNode(30);

root->left->left = newNode(40);

root->left->right = newNode(50);

printf("Height of tree is %d", height(root));

getchar();

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Height of tree is 3

**LAB – 26**

// write a program or function to find the sum all nodes in a given binary tree.

#include <stdio.h>

#include <stdlib.h>

//Represent a node of binary tree

struct node{

int data;

struct node \*left;

struct node \*right;

};

//Represent the root of binary tree

struct node \*root = NULL;

//createNode() will create a new node

struct node\* createNode(int data){

//Create a new node

struct node \*newNode = (struct node\*)malloc(sizeof(struct node));

//Assign data to newNode, set left and right children to NULL

newNode->data = data;

newNode->left = NULL;

newNode->right = NULL;

return newNode;

}

//calculateSum() will calculate the sum of all the nodes present in the binary tree

int calculateSum(struct node \*temp){

int sum, sumLeft, sumRight;

sum = sumRight = sumLeft = 0;

//Check whether tree is empty

if(root == NULL) {

printf("Tree is empty\n");

return 0;

}

else {

//Calculate the sum of nodes present in left subtree

if(temp->left != NULL)

sumLeft = calculateSum(temp->left);

//Calculate the sum of nodes present in right subtree

if(temp->right != NULL)

sumRight = calculateSum(temp->right);

//Calculate the sum of all nodes by adding sumLeft, sumRight and root node's data

sum = temp->data + sumLeft + sumRight;

return sum;

}

}

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

//Add nodes to the binary tree

root = createNode(5);

root->left = createNode(2);

root->right = createNode(9);

root->left->left = createNode(1);

root->right->left = createNode(8);

root->right->right = createNode(6);

//Display the sum of all the nodes in the given binary tree

printf("Sum of all nodes of binary tree: %d", calculateSum(root));

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Sum of all nodes of binary tree: 31

// Program to Find if the given Binary Tree is complete

#include <stdbool.h>

#include <stdio.h>

#include <stdlib.h>

#define MAX\_Q\_SIZE 500

/\* A binary tree node has data, a pointer to left child

and a pointer to right child \*/

struct node {

int data;

struct node\* left;

struct node\* right;

};

/\* function prototypes for functions needed for Queue data

structure. A queue is needed for level order traversal \*/

struct node\*\* createQueue(int\*, int\*);

void enQueue(struct node\*\*, int\*, struct node\*);

struct node\* deQueue(struct node\*\*, int\*);

bool isQueueEmpty(int\* front, int\* rear);

/\* Given a binary tree, return true if the tree is complete

else false \*/

bool isCompleteBT(struct node\* root)

{

// Base Case: An empty tree is complete Binary Tree

if (root == NULL)

return true;

// Create an empty queue

int rear, front;

struct node\*\* queue = createQueue(&front, &rear);

// Create a flag variable which will be set true

// when a non full node is seen

bool flag = false;

// Do level order traversal using queue.

enQueue(queue, &rear, root);

while (!isQueueEmpty(&front, &rear)) {

struct node\* temp\_node = deQueue(queue, &front);

/\* Check if left child is present\*/

if (temp\_node->left) {

// If we have seen a non full node, and we see a

// node with non-empty left child, then the

// given tree is not a complete Binary Tree

if (flag == true)

return false;

enQueue(queue, &rear,

temp\_node->left); // Enqueue Left Child

}

else // If this a non-full node, set the flag as

// true

flag = true;

/\* Check if right child is present\*/

if (temp\_node->right) {

// If we have seen a non full node, and we see a

// node with non-empty right child, then the

// given tree is not a complete Binary Tree

if (flag == true)

return false;

enQueue(

queue, &rear,

temp\_node->right); // Enqueue Right Child

}

else // If this a non-full node, set the flag as

// true

flag = true;

}

// If we reach here, then the tree is complete Binary

// Tree

return true;

}

/\*UTILITY FUNCTIONS\*/

struct node\*\* createQueue(int\* front, int\* rear)

{

struct node\*\* queue = (struct node\*\*)malloc(

sizeof(struct node\*) \* MAX\_Q\_SIZE);

\*front = \*rear = 0;

return queue;

}

void enQueue(struct node\*\* queue, int\* rear,

struct node\* new\_node)

{

queue[\*rear] = new\_node;

(\*rear)++;

}

struct node\* deQueue(struct node\*\* queue, int\* front)

{

(\*front)++;

return queue[\*front - 1];

}

bool isQueueEmpty(int\* front, int\* rear)

{

return (\*rear == \*front);

}

/\* Helper function that allocates a new node with the

given data and NULL left and right pointers. \*/

struct node\* newNode(int data)

{

struct node\* node

= (struct node\*)malloc(sizeof(struct node));

node->data = data;

node->left = NULL;

node->right = NULL;

return (node);

}

/\* Driver program to test above functions\*/

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

/\* Let us construct the following Binary Tree which

is not a complete Binary Tree

1

/ \

2 3

/ \ \

4 5 6

\*/

struct node\* root = newNode(1);

root->left = newNode(2);

root->right = newNode(3);

root->left->left = newNode(4);

root->left->right = newNode(5);

root->right->right = newNode(6);

if (isCompleteBT(root) == true)

printf("Complete Binary Tree");

else

printf("NOT Complete Binary Tree");

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

NOT Complete Binary Tree

// Program for Level Order Traversal

#include <stdio.h>

#include <stdlib.h>

/\* A binary tree node has data,

pointer to left child

and a pointer to right child \*/

struct node {

int data;

struct node \*left, \*right;

};

/\* Function prototypes \*/

void printCurrentLevel(struct node\* root, int level);

int height(struct node\* node);

struct node\* newNode(int data);

/\* Function to print level order traversal a tree\*/

void printLevelOrder(struct node\* root)

{

int h = height(root);

int i;

for (i = 1; i <= h; i++)

printCurrentLevel(root, i);

}

/\* Print nodes at a current level \*/

void printCurrentLevel(struct node\* root, int level)

{

if (root == NULL)

return;

if (level == 1)

printf("%d ", root->data);

else if (level > 1) {

printCurrentLevel(root->left, level - 1);

printCurrentLevel(root->right, level - 1);

}

}

/\* Compute the "height" of a tree -- the number of

nodes along the longest path from the root node

down to the farthest leaf node.\*/

int height(struct node\* node)

{

if (node == NULL)

return 0;

else {

/\* compute the height of each subtree \*/

int lheight = height(node->left);

int rheight = height(node->right);

/\* use the larger one \*/

if (lheight > rheight)

return (lheight + 1);

else

return (rheight + 1);

}

}

/\* Helper function that allocates a new node with the

given data and NULL left and right pointers. \*/

struct node\* newNode(int data)

{

struct node\* node

= (struct node\*)malloc(sizeof(struct node));

node->data = data;

node->left = NULL;

node->right = NULL;

return (node);

}

/\* Driver program to test above functions\*/

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

struct node\* root = newNode(1);

root->left = newNode(2);

root->right = newNode(3);

root->left->left = newNode(4);

root->left->right = newNode(5);

printf("Level Order traversal of binary tree is \n");

printLevelOrder(root);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Level Order traversal of binary tree is

1 2 3 4 5

**LAB – 27**

// Write a program to create a copy of the given Binary Tree

#include <stdio.h>

#include <limits.h>

struct node {

int data;

struct node \*left;

struct node \*right;

};

struct node\* getNewNode(int data) {

/\* dynamically allocate memory for a new node \*/

struct node\* newNode = (struct node\*)malloc(sizeof(struct node));

/\* populate data in new Node \*/

newNode->data = data;

newNode->left = NULL;

newNode->right = NULL;

return newNode;

}

/\*

This function returns below tree

1

/ \

9 12

/ \ \

4 50 -7

/ \

18 9

\*/

struct node\* generateBTree(){

// Root Node

struct node\* root = getNewNode(1);

root->left = getNewNode(9);

root->right = getNewNode(12);

root->left->left = getNewNode(4);

root->left->right = getNewNode(50);

root->right->right = getNewNode(-7);

root->left->left->left = getNewNode(18);

root->left->left->right = getNewNode(9);

return root;

}

/\* Returns a tree which is exact copy of passed tree \*/

struct node\* cloneBinaryTree(struct node \*root){

if(root == NULL)

return NULL;

/\* create a copy of root node \*/

struct node\* newNode = getNewNode(root->data);

/\* Recursively create clone of left and right sub tree \*/

newNode->left = cloneBinaryTree(root->left);

newNode->right = cloneBinaryTree(root->right);

/\* Return root of cloned tree \*/

return newNode;

}

/\*

Prints inOrder Traversal of a binary tree

\*/

void inOrderTraversal(struct node \*nodeptr){

if(nodeptr != NULL){

/\* First, recursively prints in Order traversal of left sub-tree \*/

inOrderTraversal(nodeptr->left);

/\* Prints current node \*/

printf("%d ", nodeptr->data);

/\* Recursively prints in Order traversal of right sub-tree \*/

inOrderTraversal(nodeptr->right);

}

}

int main() {

printf("ARYAN ARORA CS-A 2100320120032\n");

struct node \*clone, \*root = generateBTree();

/\*InOrder traversal of original tree \*/

printf("Original Tree\n");

inOrderTraversal(root);

clone = cloneBinaryTree(root);

/\*InOrder traversal of clone tree \*/

printf("\nClone Tree\n");

inOrderTraversal(clone);

getchar();

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Original Tree

18 4 9 9 50 1 12 -7

Clone Tree

18 4 9 9 50 1 12 -7

// write a program to check if the given tree is BST or not.

#include <limits.h>

#include <stdio.h>

#include <stdlib.h>

/\* A binary tree node has data, pointer to left child

and a pointer to right child \*/

struct node {

int data;

struct node\* left;

struct node\* right;

};

/\* Helper function that allocates a new node with the

given data and NULL left and right pointers. \*/

struct node\* newNode(int data)

{

struct node\* node

= (struct node\*)malloc(sizeof(struct node));

node->data = data;

node->left = NULL;

node->right = NULL;

return (node);

}

int maxValue(struct node\* node)

{

if (node == NULL) {

return 0;

}

int leftMax = maxValue(node->left);

int rightMax = maxValue(node->right);

int value = 0;

if (leftMax > rightMax) {

value = leftMax;

}

else {

value = rightMax;

}

if (value < node->data) {

value = node->data;

}

return value;

}

int minValue(struct node\* node)

{

if (node == NULL) {

return 1000000000;

}

int leftMax = minValue(node->left);

int rightMax = minValue(node->right);

int value = 0;

if (leftMax < rightMax) {

value = leftMax;

}

else {

value = rightMax;

}

if (value > node->data) {

value = node->data;

}

return value;

}

/\* Returns true if a binary tree is a binary search tree \*/

int isBST(struct node\* node)

{

if (node == NULL)

return 1;

/\* false if the max of the left is > than us \*/

if (node->left != NULL

&& maxValue(node->left) > node->data)

return 0;

/\* false if the min of the right is <= than us \*/

if (node->right != NULL

&& minValue(node->right) < node->data)

return 0;

/\* false if, recursively, the left or right is not a BST

\*/

if (!isBST(node->left) || !isBST(node->right))

return 0;

/\* passing all that, it's a BST \*/

return 1;

}

/\* Driver code\*/

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

struct node\* root = newNode(4);

root->left = newNode(5);

root->right = newNode(6);

// root->left->left = newNode(1);

//root->left->right = newNode(3);

// Function call

if (isBST(root))

printf("Is BST");

else

printf("Not a BST");

getchar();

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Not a BST

// write a program to implement Insertion and Search operation in BST (Iterative)

#include<stdio.h>

#include<stdlib.h>

void insert(int);

struct node

{

int data;

struct node \*left;

struct node \*right;

};

struct node \*root;

int main ()

{

int choice,item;

do

{

printf("\nEnter the item which you want to insert?\n");

scanf("%d",&item);

insert(item);

printf("\nPress 0 to insert more ?\n");

scanf("%d",&choice);

}while(choice == 0);

return 0;

}

void insert(int item)

{

struct node \*ptr, \*parentptr , \*nodeptr;

ptr = (struct node \*) malloc(sizeof (struct node));

if(ptr == NULL)

{

printf("can't insert");

}

else

{

ptr -> data = item;

ptr -> left = NULL;

ptr -> right = NULL;

if(root == NULL)

{

root = ptr;

root -> left = NULL;

root -> right = NULL;

}

else

{

parentptr = NULL;

nodeptr = root;

while(nodeptr != NULL)

{

parentptr = nodeptr;

if(item < nodeptr->data)

{

nodeptr = nodeptr -> left;

}

else

{

nodeptr = nodeptr -> right;

}

}

if(item < parentptr -> data)

{

parentptr -> left = ptr;

}

else

{

parentptr -> right = ptr;

}

}

printf("Node Inserted");

}

}

OUTPUT:

Enter the item which you want to insert?

4

Node Inserted

Press 0 to insert more ?

0

Enter the item which you want to insert?

2

Node Inserted

Press 0 to insert more ?

**LAB – 28**

// Program to find the diameter of the Binary Tree (distance between the farthest node)

// Recursive optimized C program to find the diameter of a

// Binary Tree

#include <stdio.h>

#include <stdlib.h>

// A binary tree node has data, pointer to left child

// and a pointer to right child

struct node {

int data;

struct node \*left, \*right;

};

// function to create a new node of tree and returns pointer

struct node\* newNode(int data);

// returns max of two integers

int max(int a, int b) { return (a > b) ? a : b; }

// function to Compute height of a tree.

int height(struct node\* node);

// Function to get diameter of a binary tree

int diameter(struct node\* tree)

{

// base case where tree is empty

if (tree == NULL)

return 0;

// get the height of left and right sub-trees

int lheight = height(tree->left);

int rheight = height(tree->right);

// get the diameter of left and right sub-trees

int ldiameter = diameter(tree->left);

int rdiameter = diameter(tree->right);

// Return max of following three

// 1) Diameter of left subtree

// 2) Diameter of right subtree

// 3) Height of left subtree + height of right subtree +

// 1

return max(lheight + rheight + 1,

max(ldiameter, rdiameter));

}

// UTILITY FUNCTIONS TO TEST diameter() FUNCTION

// The function Compute the "height" of a tree. Height is

// the number f nodes along the longest path from the root

// node down to the farthest leaf node.

int height(struct node\* node)

{

// base case tree is empty

if (node == NULL)

return 0;

// If tree is not empty then height = 1 + max of left

// height and right heights

return 1 + max(height(node->left), height(node->right));

}

// Helper function that allocates a new node with the

// given data and NULL left and right pointers.

struct node\* newNode(int data)

{

struct node\* node

= (struct node\*)malloc(sizeof(struct node));

node->data = data;

node->left = NULL;

node->right = NULL;

return (node);

}

// Driver Code

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

/\* Constructed binary tree is

1

/ \

2 3

/ \

4 5

\*/

struct node\* root = newNode(1);

root->left = newNode(2);

root->right = newNode(3);

root->left->left = newNode(4);

root->left->right = newNode(5);

// Function Call

printf("Diameter of the given binary tree is %d\n",

diameter(root));

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Diameter of the given binary tree is 4

// write a program to implement deletion in BST.

// C program to demonstrate

// delete operation in binary

// search tree

#include <stdio.h>

#include <stdlib.h>

struct node {

int key;

struct node \*left, \*right;

};

// A utility function to create a new BST node

struct node\* newNode(int item)

{

struct node\* temp

= (struct node\*)malloc(sizeof(struct node));

temp->key = item;

temp->left = temp->right = NULL;

return temp;

}

// A utility function to do inorder traversal of BST

void inorder(struct node\* root)

{

if (root != NULL) {

inorder(root->left);

printf("%d ", root->key);

inorder(root->right);

}

}

/\* A utility function to

insert a new node with given key in

\* BST \*/

struct node\* insert(struct node\* node, int key)

{

/\* If the tree is empty, return a new node \*/

if (node == NULL)

return newNode(key);

/\* Otherwise, recur down the tree \*/

if (key < node->key)

node->left = insert(node->left, key);

else

node->right = insert(node->right, key);

/\* return the (unchanged) node pointer \*/

return node;

}

/\* Given a non-empty binary search

tree, return the node

with minimum key value found in

that tree. Note that the

entire tree does not need to be searched. \*/

struct node\* minValueNode(struct node\* node)

{

struct node\* current = node;

/\* loop down to find the leftmost leaf \*/

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

current = current->left;

return current;

}

/\* Given a binary search tree

and a key, this function

deletes the key and

returns the new root \*/

struct node\* deleteNode(struct node\* root, int key)

{

// base case

if (root == NULL)

return root;

// If the key to be deleted

// is smaller than the root's

// key, then it lies in left subtree

if (key < root->key)

root->left = deleteNode(root->left, key);

// If the key to be deleted

// is greater than the root's

// key, then it lies in right subtree

else if (key > root->key)

root->right = deleteNode(root->right, key);

// if key is same as root's key,

// then This is the node

// to be deleted

else {

// node with only one child or no child

if (root->left == NULL) {

struct node\* temp = root->right;

free(root);

return temp;

}

else if (root->right == NULL) {

struct node\* temp = root->left;

free(root);

return temp;

}

// node with two children:

// Get the inorder successor

// (smallest in the right subtree)

struct node\* temp = minValueNode(root->right);

// Copy the inorder

// successor's content to this node

root->key = temp->key;

// Delete the inorder successor

root->right = deleteNode(root->right, temp->key);

}

return root;

}

// Driver Code

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

/\* Let us create following BST

50

/ \

30 70

/ \ / \

20 40 60 80 \*/

struct node\* root = NULL;

root = insert(root, 50);

root = insert(root, 30);

root = insert(root, 20);

root = insert(root, 40);

root = insert(root, 70);

root = insert(root, 60);

root = insert(root, 80);

printf("Inorder traversal of the given tree \n");

inorder(root);

printf("\nDelete 20\n");

root = deleteNode(root, 20);

printf("Inorder traversal of the modified tree \n");

inorder(root);

printf("\nDelete 30\n");

root = deleteNode(root, 30);

printf("Inorder traversal of the modified tree \n");

inorder(root);

printf("\nDelete 50\n");

root = deleteNode(root, 50);

printf("Inorder traversal of the modified tree \n");

inorder(root);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Inorder traversal of the given tree

20 30 40 50 60 70 80

Delete 20

Inorder traversal of the modified tree

30 40 50 60 70 80

Delete 30

Inorder traversal of the modified tree

40 50 60 70 80

Delete 50

Inorder traversal of the modified tree

40 60 70 80

// Write a Program for BST insertion (using Recursion)

#include <stdio.h>

#include <stdlib.h>

struct node{

int data;

struct node \*left;

struct node \*right;

};

struct node \*root = NULL;

struct node \*newNode(int data){

struct node \*temp = (struct node \*)malloc(sizeof(struct node));

temp->data = data;

temp->left = NULL;

temp->right = NULL;

return temp;

}

//SEARCH FUNCTION 1: this does not work correctly

void search(struct node \*t,int data){

if(t){

if(data > t->data){

search(t->right,data);

}else{

search(t->left,data);

}

}else{

t = newNode(data);

}

}

//SEARCH FUNCTION 2: this works fine and inserts the element correctly

void search2(struct node \*t, int data){

if(data < t->data && t->left != NULL){

search(t->left, data);

}else if(data < t->data && t->left == NULL){

t->left = newNode(data);

}else if(data > t->data && t->right != NULL){

search(t->right,data);

}else{

t->right = newNode(data);

}

}

void insertNode(int data){

if(!root){

root = newNode(data);

return;

}

search(root, data);

}

void inorder(struct node \*t){

if(t){

if(t->left){

inorder(t->left);

}

printf("%d ->", t->data);

if(t->right){

inorder(t->right);

}

}

}

int main(){

printf("ARYAN ARORA CS-A 2100320120032\n");

int step, data;

while(1){

printf("1. Insert element\n");

printf("2. Print tree\n");

scanf("%d",&step);

switch(step){

case 1: printf("enter element to be inserted\n");

scanf("%d",&data);

insertNode(data);

break;

case 2:inorder(root);

printf("\n");

break;

}

}

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

1. Insert element

2. Print tree

1

enter element to be inserted

2

1. Insert element

2. Print tree

1

enter element to be inserted

5

1. Insert element

2. Print tree

1

enter element to be inserted

6

1. Insert element

2. Print tree

18

1. Insert element

2. Print tree

1

enter element to be inserted

99

1. Insert element

2. Print tree

2

2 ->

1. Insert element

2. Print tree

2

2 ->

1. Insert element

2. Print tree

// write a program to perform insertion operation for AVL tree.

// C program to insert a node in AVL tree

#include<stdio.h>

#include<stdlib.h>

// An AVL tree node

struct Node

{

int key;

struct Node \*left;

struct Node \*right;

int height;

};

// A utility function to get the height of the tree

int height(struct Node \*N)

{

if (N == NULL)

return 0;

return N->height;

}

// A utility function to get maximum of two integers

int max(int a, int b)

{

return (a > b)? a : b;

}

/\* Helper function that allocates a new node with the given key and

NULL left and right pointers. \*/

struct Node\* newNode(int key)

{

struct Node\* node = (struct Node\*)

malloc(sizeof(struct Node));

node->key = key;

node->left = NULL;

node->right = NULL;

node->height = 1; // new node is initially added at leaf

return(node);

}

// A utility function to right rotate subtree rooted with y

// See the diagram given above.

struct Node \*rightRotate(struct Node \*y)

{

struct Node \*x = y->left;

struct Node \*T2 = x->right;

// Perform rotation

x->right = y;

y->left = T2;

// Update heights

y->height = max(height(y->left),

height(y->right)) + 1;

x->height = max(height(x->left),

height(x->right)) + 1;

// Return new root

return x;

}

// A utility function to left rotate subtree rooted with x

// See the diagram given above.

struct Node \*leftRotate(struct Node \*x)

{

struct Node \*y = x->right;

struct Node \*T2 = y->left;

// Perform rotation

y->left = x;

x->right = T2;

// Update heights

x->height = max(height(x->left),

height(x->right)) + 1;

y->height = max(height(y->left),

height(y->right)) + 1;

// Return new root

return y;

}

// Get Balance factor of node N

int getBalance(struct Node \*N)

{

if (N == NULL)

return 0;

return height(N->left) - height(N->right);

}

// Recursive function to insert a key in the subtree rooted

// with node and returns the new root of the subtree.

struct Node\* insert(struct Node\* node, int key)

{

/\* 1. Perform the normal BST insertion \*/

if (node == NULL)

return(newNode(key));

if (key < node->key)

node->left = insert(node->left, key);

else if (key > node->key)

node->right = insert(node->right, key);

else // Equal keys are not allowed in BST

return node;

/\* 2. Update height of this ancestor node \*/

node->height = 1 + max(height(node->left),

height(node->right));

/\* 3. Get the balance factor of this ancestor

node to check whether this node became

unbalanced \*/

int balance = getBalance(node);

// If this node becomes unbalanced, then

// there are 4 cases

// Left Left Case

if (balance > 1 && key < node->left->key)

return rightRotate(node);

// Right Right Case

if (balance < -1 && key > node->right->key)

return leftRotate(node);

// Left Right Case

if (balance > 1 && key > node->left->key)

{

node->left = leftRotate(node->left);

return rightRotate(node);

}

// Right Left Case

if (balance < -1 && key < node->right->key)

{

node->right = rightRotate(node->right);

return leftRotate(node);

}

/\* return the (unchanged) node pointer \*/

return node;

}

// A utility function to print preorder traversal

// of the tree.

// The function also prints height of every node

void preOrder(struct Node \*root)

{

if(root != NULL)

{

printf("%d ", root->key);

preOrder(root->left);

preOrder(root->right);

}

}

/\* Driver program to test above function\*/

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

struct Node \*root = NULL;

/\* Constructing tree given in the above figure \*/

root = insert(root, 10);

root = insert(root, 20);

root = insert(root, 30);

root = insert(root, 40);

root = insert(root, 50);

root = insert(root, 25);

/\* The constructed AVL Tree would be

30

/ \

20 40

/ \ \

10 25 50

\*/

printf("Preorder traversal of the constructed AVL"" tree is \n");

preOrder(root);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Preorder traversal of the constructed AVL tree is

30 20 10 25 40 50

**LAB – 29**

// Program for Heap Sort

#include <stdio.h>

// Function to swap the position of two elements

void swap(int\* a, int\* b)

{

int temp = \*a;

\*a = \*b;

\*b = temp;

}

// To heapify a subtree rooted with node i

// which is an index in arr[].

// n is size of heap

void heapify(int arr[], int N, int i)

{

// Find largest among root, left child and right child

// Initialize largest as root

int largest = i;

// left = 2\*i + 1

int left = 2 \* i + 1;

// right = 2\*i + 2

int right = 2 \* i + 2;

// If left child is larger than root

if (left < N && arr[left] > arr[largest])

largest = left;

// If right child is larger than largest

// so far

if (right < N && arr[right] > arr[largest])

largest = right;

// Swap and continue heapifying if root is not largest

// If largest is not root

if (largest != i) {

swap(&arr[i], &arr[largest]);

// Recursively heapify the affected

// sub-tree

heapify(arr, N, largest);

}

}

// Main function to do heap sort

void heapSort(int arr[], int N)

{

// Build max heap

for (int i = N / 2 - 1; i >= 0; i--)

heapify(arr, N, i);

// Heap sort

for (int i = N - 1; i >= 0; i--) {

swap(&arr[0], &arr[i]);

// Heapify root element to get highest element at

// root again

heapify(arr, i, 0);

}

}

// A utility function to print array of size n

void printArray(int arr[], int N)

{

for (int i = 0; i < N; i++)

printf("%d ", arr[i]);

printf("\n");

}

// Driver's code

int main()

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int arr[] = { 12, 11, 13, 5, 6, 7 };

int N = sizeof(arr) / sizeof(arr[0]);

// Function call

heapSort(arr, N);

printf("Sorted array is\n");

printArray(arr, N);

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Sorted array is

5 6 7 11 12 13

//Program for Heap Implementation of Priority Queue

#include <stdio.h>

int tree\_array\_size = 20;

int heap\_size = 0;

const int INF = 100000;

void swap( int \*a, int \*b ) {

int t;

t = \*a;

\*a = \*b;

\*b = t;

}

//function to get right child of a node of a tree

int get\_right\_child(int A[], int index) {

if((((2\*index)+1) < tree\_array\_size) && (index >= 1))

return (2\*index)+1;

return -1;

}

//function to get left child of a node of a tree

int get\_left\_child(int A[], int index) {

if(((2\*index) < tree\_array\_size) && (index >= 1))

return 2\*index;

return -1;

}

//function to get the parent of a node of a tree

int get\_parent(int A[], int index) {

if ((index > 1) && (index < tree\_array\_size)) {

return index/2;

}

return -1;

}

void max\_heapify(int A[], int index) {

int left\_child\_index = get\_left\_child(A, index);

int right\_child\_index = get\_right\_child(A, index);

// finding largest among index, left child and right child

int largest = index;

if ((left\_child\_index <= heap\_size) && (left\_child\_index>0)) {

if (A[left\_child\_index] > A[largest]) {

largest = left\_child\_index;

}

}

if ((right\_child\_index <= heap\_size && (right\_child\_index>0))) {

if (A[right\_child\_index] > A[largest]) {

largest = right\_child\_index;

}

}

// largest is not the node, node is not a heap

if (largest != index) {

swap(&A[index], &A[largest]);

max\_heapify(A, largest);

}

}

void build\_max\_heap(int A[]) {

int i;

for(i=heap\_size/2; i>=1; i--) {

max\_heapify(A, i);

}

}

int maximum(int A[]) {

return A[1];

}

int extract\_max(int A[]) {

int maxm = A[1];

A[1] = A[heap\_size];

heap\_size--;

max\_heapify(A, 1);

return maxm;

}

void increase\_key(int A[], int index, int key) {

A[index] = key;

while((index>1) && (A[get\_parent(A, index)] < A[index])) {

swap(&A[index], &A[get\_parent(A, index)]);

index = get\_parent(A, index);

}

}

void decrease\_key(int A[], int index, int key) {

A[index] = key;

max\_heapify(A, index);

}

void insert(int A[], int key) {

heap\_size++;

A[heap\_size] = -1\*INF;

increase\_key(A, heap\_size, key);

}

void print\_heap(int A[]) {

int i;

for(i=1; i<=heap\_size; i++) {

printf("%d\n",A[i]);

}

printf("\n");

}

int main() {

printf("ARYAN ARORA CS-A 2100320120032\n");

int A[tree\_array\_size];

insert(A, 20);

insert(A, 15);

insert(A, 8);

insert(A, 10);

insert(A, 5);

insert(A, 7);

insert(A, 6);

insert(A, 2);

insert(A, 9);

insert(A, 1);

print\_heap(A);

increase\_key(A, 5, 22);

print\_heap(A);

decrease\_key(A, 1, 13);

print\_heap(A);

printf("%d\n\n", maximum(A));

printf("%d\n\n", extract\_max(A));

print\_heap(A);

printf("%d\n", extract\_max(A));

printf("%d\n", extract\_max(A));

printf("%d\n", extract\_max(A));

printf("%d\n", extract\_max(A));

printf("%d\n", extract\_max(A));

printf("%d\n", extract\_max(A));

printf("%d\n", extract\_max(A));

printf("%d\n", extract\_max(A));

printf("%d\n", extract\_max(A));

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

20

15

8

10

5

7

6

2

9

1

22

20

8

10

15

7

6

2

9

1

20

15

8

10

13

7

6

2

9

1

20

20

15

13

8

10

1

7

6

2

9

15

13

10

9

8

7

6

2

1

//Program for BFS on a Graph

#include <stdio.h>

#include <stdlib.h>

#define SIZE 40

struct queue {

int items[SIZE];

int front;

int rear;

};

struct queue\* createQueue();

void enqueue(struct queue\* q, int);

int dequeue(struct queue\* q);

void display(struct queue\* q);

int isEmpty(struct queue\* q);

void printQueue(struct queue\* q);

struct node {

int vertex;

struct node\* next;

};

struct node\* createNode(int);

struct Graph {

int numVertices;

struct node\*\* adjLists;

int\* visited;

};

// BFS algorithm

void bfs(struct Graph\* graph, int startVertex) {

struct queue\* q = createQueue();

graph->visited[startVertex] = 1;

enqueue(q, startVertex);

while (!isEmpty(q)) {

printQueue(q);

int currentVertex = dequeue(q);

printf("Visited %d\n", currentVertex);

struct node\* temp = graph->adjLists[currentVertex];

while (temp) {

int adjVertex = temp->vertex;

if (graph->visited[adjVertex] == 0) {

graph->visited[adjVertex] = 1;

enqueue(q, adjVertex);

}

temp = temp->next;

}

}

}

// Creating a node

struct node\* createNode(int v) {

struct node\* newNode = malloc(sizeof(struct node));

newNode->vertex = v;

newNode->next = NULL;

return newNode;

}

// Creating a graph

struct Graph\* createGraph(int vertices) {

struct Graph\* graph = malloc(sizeof(struct Graph));

graph->numVertices = vertices;

graph->adjLists = malloc(vertices \* sizeof(struct node\*));

graph->visited = malloc(vertices \* sizeof(int));

int i;

for (i = 0; i < vertices; i++) {

graph->adjLists[i] = NULL;

graph->visited[i] = 0;

}

return graph;

}

// Add edge

void addEdge(struct Graph\* graph, int src, int dest) {

// Add edge from src to dest

struct node\* newNode = createNode(dest);

newNode->next = graph->adjLists[src];

graph->adjLists[src] = newNode;

// Add edge from dest to src

newNode = createNode(src);

newNode->next = graph->adjLists[dest];

graph->adjLists[dest] = newNode;

}

// Create a queue

struct queue\* createQueue() {

struct queue\* q = malloc(sizeof(struct queue));

q->front = -1;

q->rear = -1;

return q;

}

// Check if the queue is empty

int isEmpty(struct queue\* q) {

if (q->rear == -1)

return 1;

else

return 0;

}

// Adding elements into queue

void enqueue(struct queue\* q, int value) {

if (q->rear == SIZE - 1)

printf("\nQueue is Full!!");

else {

if (q->front == -1)

q->front = 0;

q->rear++;

q->items[q->rear] = value;

}

}

// Removing elements from queue

int dequeue(struct queue\* q) {

int item;

if (isEmpty(q)) {

printf("Queue is empty");

item = -1;

} else {

item = q->items[q->front];

q->front++;

if (q->front > q->rear) {

printf("Resetting queue ");

q->front = q->rear = -1;

}

}

return item;

}

// Print the queue

void printQueue(struct queue\* q) {

int i = q->front;

if (isEmpty(q)) {

printf("Queue is empty");

} else {

printf("\nQueue contains \n");

for (i = q->front; i < q->rear + 1; i++) {

printf("%d ", q->items[i]);

}

}

}

int main() {

printf("ARYAN ARORA CS-A 2100320120032\n");

struct Graph\* graph = createGraph(6);

addEdge(graph, 0, 1);

addEdge(graph, 0, 2);

addEdge(graph, 1, 2);

addEdge(graph, 1, 4);

addEdge(graph, 1, 3);

addEdge(graph, 2, 4);

addEdge(graph, 3, 4);

bfs(graph, 0);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Queue contains

0 Resetting queue Visited 0

Queue contains

2 1 Visited 2

Queue contains

1 4 Visited 1

Queue contains

4 3 Visited 4

Queue contains

3 Resetting queue Visited 3

l

dash: 2: l: not found

1

dash: 3: 1: not found

//Program for DFS on a Graph

#include <stdio.h>

#include <stdlib.h>

struct node {

int vertex;

struct node\* next;

};

struct node\* createNode(int v);

struct Graph {

int numVertices;

int\* visited;

// We need int\*\* to store a two dimensional array.

// Similary, we need struct node\*\* to store an array of Linked lists

struct node\*\* adjLists;

};

// DFS algo

void DFS(struct Graph\* graph, int vertex) {

struct node\* adjList = graph->adjLists[vertex];

struct node\* temp = adjList;

graph->visited[vertex] = 1;

printf("Visited %d \n", vertex);

while (temp != NULL) {

int connectedVertex = temp->vertex;

if (graph->visited[connectedVertex] == 0) {

DFS(graph, connectedVertex);

}

temp = temp->next;

}

}

// Create a node

struct node\* createNode(int v) {

struct node\* newNode = malloc(sizeof(struct node));

newNode->vertex = v;

newNode->next = NULL;

return newNode;

}

// Create graph

struct Graph\* createGraph(int vertices) {

struct Graph\* graph = malloc(sizeof(struct Graph));

graph->numVertices = vertices;

graph->adjLists = malloc(vertices \* sizeof(struct node\*));

graph->visited = malloc(vertices \* sizeof(int));

int i;

for (i = 0; i < vertices; i++) {

graph->adjLists[i] = NULL;

graph->visited[i] = 0;

}

return graph;

}

// Add edge

void addEdge(struct Graph\* graph, int src, int dest) {

// Add edge from src to dest

struct node\* newNode = createNode(dest);

newNode->next = graph->adjLists[src];

graph->adjLists[src] = newNode;

// Add edge from dest to src

newNode = createNode(src);

newNode->next = graph->adjLists[dest];

graph->adjLists[dest] = newNode;

}

// Print the graph

void printGraph(struct Graph\* graph) {

int v;

for (v = 0; v < graph->numVertices; v++) {

struct node\* temp = graph->adjLists[v];

printf("\n Adjacency list of vertex %d\n ", v);

while (temp) {

printf("%d -> ", temp->vertex);

temp = temp->next;

}

printf("\n");

}

}

int main() {

printf("ARYAN ARORA CS-A 2100320120032\n");

struct Graph\* graph = createGraph(4);

addEdge(graph, 0, 1);

addEdge(graph, 0, 2);

addEdge(graph, 1, 2);

addEdge(graph, 2, 3);

printGraph(graph);

DFS(graph, 2);

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Adjacency list of vertex 0

2 -> 1 ->

Adjacency list of vertex 1

2 -> 0 ->

Adjacency list of vertex 2

3 -> 1 -> 0 ->

Adjacency list of vertex 3

2 ->

Visited 2

Visited 3

Visited 1

Visited 0

**LAB -30**

//Program to find the number of connected components in the undirected Graph

class Graph:

print("ARYAN ARORA CS-A 2100320120032\n");

def \_\_init\_\_(self, V):

# No. of vertices

self.V = V

# Pointer to an array containing

# adjacency lists

self.adj = [[] for i in range(self.V)]

# Function to return the number of

# connected components in an undirected graph

def NumberOfconnectedComponents(self):

# Mark all the vertices as not visited

visited = [False for i in range(self.V)]

# To store the number of connected

# components

count = 0

for v in range(self.V):

if (visited[v] == False):

self.DFSUtil(v, visited)

count += 1

return count

def DFSUtil(self, v, visited):

# Mark the current node as visited

visited[v] = True

# Recur for all the vertices

# adjacent to this vertex

for i in self.adj[v]:

if (not visited[i]):

self.DFSUtil(i, visited)

# Add an undirected edge

def addEdge(self, v, w):

self.adj[v].append(w)

self.adj[w].append(v)

# Driver code

if \_\_name\_\_=='\_\_main\_\_':

g = Graph(5)

g.addEdge(1, 0)

g.addEdge(2, 3)

g.addEdge(3, 4)

print(g.NumberOfconnectedComponents())

OUTPUT:

ARYAN ARORA CS-A 2100320120032

2

//Program for Warshall's Algorithm for APSP

#include <stdio.h>

#include <stdlib.h>

void floydWarshall(int \*\*graph, int n)

{

int i, j, k;

for (k = 0; k < n; k++)

{

for (i = 0; i < n; i++)

{

for (j = 0; j < n; j++)

{

if (graph[i][j] > graph[i][k] + graph[k][j])

graph[i][j] = graph[i][k] + graph[k][j];

}

}

}

}

int main(void)

{

printf("ARYAN ARORA CS-A 2100320120032\n");

int n, i, j;

printf("Enter the number of vertices: ");

scanf("%d", &n);

int \*\*graph = (int \*\*)malloc((long unsigned) n \* sizeof(int \*));

for (i = 0; i < n; i++)

{

graph[i] = (int \*)malloc((long unsigned) n \* sizeof(int));

}

for (i = 0; i < n; i++)

{

for (j = 0; j < n; j++)

{

if (i == j)

graph[i][j] = 0;

else

graph[i][j] = 100;

}

}

printf("Enter the edges: \n");

for (i = 0; i < n; i++)

{

for (j = 0; j < n; j++)

{

printf("[%d][%d]: ", i, j);

scanf("%d", &graph[i][j]);

}

}

printf("The original graph is:\n");

for (i = 0; i < n; i++)

{

for (j = 0; j < n; j++)

{

printf("%d ", graph[i][j]);

}

printf("\n");

}

floydWarshall(graph, n);

printf("The shortest path matrix is:\n");

for (i = 0; i < n; i++)

{

for (j = 0; j < n; j++)

{

printf("%d ", graph[i][j]);

}

printf("\n");

}

return 0;

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Enter the number of vertices: 3

Enter the edges:

[0][0]: 12

[0][1]: 23

[0][2]: 34

[1][0]: 56

[1][1]: 45

[1][2]: 78

[2][0]: 35

[2][1]: 67

[2][2]: 58

The original graph is:

12 23 34

56 45 78

35 67 58

The shortest path matrix is:

12 23 34

56 45 78

35 58 58

//Program For Linked List Implementation of General Sparse Matrix

#include<stdio.h>

#include<stdlib.h>

int main(){

printf("ARYAN ARORA CS-A 2100320120032\n");

int row,col,i,j,a[10][10],count = 0;

printf("Enter row");

scanf("%d",&row);

printf("Enter Column");

scanf("%d",&col);

printf("Enter Element of Matrix1");

for(i = 0; i < row; i++){

for(j = 0; j < col; j++){

scanf("%d",&a[i][j]);

}

}

printf("Elements are:");

for(i = 0; i < row; i++){

for(j = 0; j < col; j++){

printf("%d\t",a[i][j]);

}

printf("");

}

/\*checking sparse of matrix\*/

for(i = 0; i < row; i++){

for(j = 0; j < col; j++){

if(a[i][j] == 0)

count++;

}

}

if(count > ((row \* col)/2))

printf("Matrix is a sparse matrix ");

else

printf("Matrix is not sparse matrix");

}

OUTPUT:

ARYAN ARORA CS-A 2100320120032

Enter row2

Enter Column2

Enter Element of Matrix11

2

4

5

Elements are:1 2 4 5 Matrix is not sparse matrix