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Pro Material Series

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1. Addition Of Two Matrices In C:

1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32.

```
#include <stdio.h>

int main() {

int m, n, c, d, first[1 0][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; }
```

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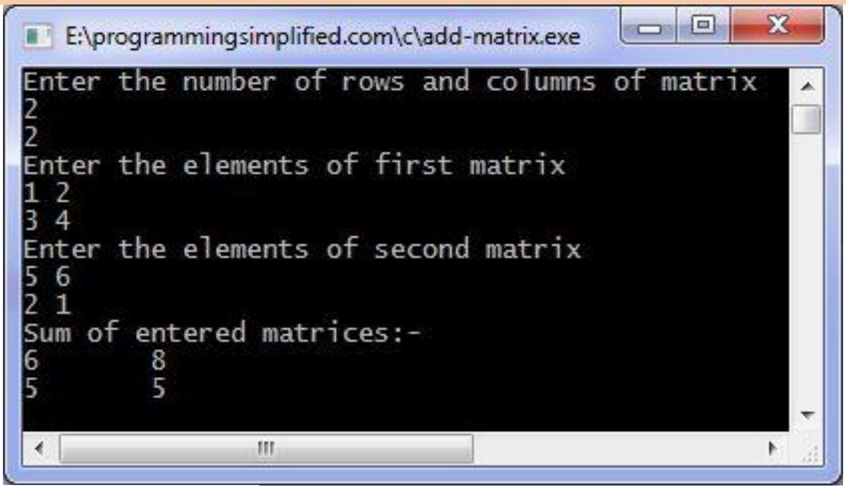
Output:

2. Program to find the average of n (n < 10) numbers using arrays

```
#include <stdio.h> int main()
{

int marks[10], i, n, sum = 0, average; printf("Enter n: ");
scanf("%d", &n);
for(i=0; i<n; ++i)

{
printf("Enter number%d: ",i+1); scanf("%d", &marks[i]);
sum += marks[i];

     }
     average = sum/n;

printf("Average = %d", average); return 0;

}
```



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Output:

```
Enter n: 5
Enter number1: 45
Enter number2: 35
Enter number3: 38
Enter number4: 31
Enter number5: 49
Average = 39
```

3. C program To Implement Linked List

1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24.

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

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

```
};

struct node *start = NULL; void insert_at_begin(int) ; void
insert_at_end(int); void traverse();

void delete_from_begin(); void delete_from_end(); int count = 0;

int main () {
int input, data;

for (;;) {
printf("1. Insert an element at beginning of linked list.\n"); printf("2.
Insert an element at end of linked list.\n"); printf("3. Traverse linked
list.\n");
printf("4. Delete element from beginning.\n");
```

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25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60.

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```
printf("5. Delete element from end.\n"); printf("6. Exit\n");

scanf("%d", &input);

if (input == 1 ) {
printf("Enter value of element\n"); scanf("%d", &data);
insert_at_begin(d ata);

}
else if (input == 2) {

printf("Enter value of element\n"); scanf("%d", &data); insert_at_end(
data);
```

```
}
else if (input == 3)

traverse();
else if (input == 4)

delete_from_begin(); else if (input == 5)

delete_from_end(); else if (input == 6)

break; else

printf("Please enter valid input.\n"); }

return 0; }

void insert_at_begin(int x) { struct node *t;

t = (struct node*)malloc(sizeof(struct node)); count++;
```


61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96.

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```
if (start == NULL) { start = t; start->data = x; start->next = NULL;
return;

}

t->data = x; t->next = start; start = t;

}
void insert_at_end(int x) {
```

```
struct node *t, *temp;
t = (struct node*)malloc(sizeof(struct node));

count++;

if (start == NULL) { start = t; start->data = x; start->next = NULL;
return;

}

temp = start;

while (temp->next != NULL) temp = temp->next;

temp->next = t; t->data = x; t->next = NULL;

}
void traverse() {
```

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```
97. struct node *t; 98.
99. t = start;
100.

101.        if (t == NULL) {
102.        printf("Linked list is empty.\n");
103.        return;
104.        }

105.
106. printf("There are %d elements in linked list.\n", count) ; 107.

108.        while (t->next != NULL) {
109.        printf("%d\n" , t- >data);
110.        t = t->next;
```

```
}
printf("%d\n", t->data);
}

void delete_from_begin() {
struct node *t;
int n;

if (start == NULL) {
printf("Linked list is already empty.\n");
return;
}

n = start->d ata;
t = start->next;
free(start);
start = t;
count--;

printf("%d deleted from beginning successfully.\n", n);
}
```



```
void delete_from_end() {
struct node *t, *u;
```

```
int n;

if (start == NULL) {
printf("Linked list is already empty.\n");
return;
}

count--;
if

}

t = start;

while (t->next != NULL) {
u = t;
t = t->next;
}

n = t->data;
u->next = NULL;
free(t);

printf("%d deleted from end successfully.\n", n) ;
}
```

4. Operations On Linked List

```
(start->next == NULL) { n = start->data; free(start);
start = NULL;

printf("%d deleted from end successfully.\n", n); return;
```

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

struct node {

int data;

struct node *next; };

void display(struct node* head) {

struct node *temp = head; printf("\n\nList elements are - \n");
while(temp != NULL)
{

printf("%d --->",temp->data); temp = temp->next;

} }

void insertAtMiddle(struct node *head, int position, int value) {
struct node *temp = head;
struct node *newNode;
newNode = malloc(sizeof(struct node));

newNode->data = value;

int i;

for(i=2; inext != NULL) { temp = temp->next;
}

}
newNode->next = temp->next; temp->next = newNode;

}
```

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```
void insertAtFront(struct node** headRef, int value) { struct node*
head = *headRef;

struct node *newNode;
newNode = malloc(sizeof(struct node)); newNode->data = value;
newNode->next = head;
head = newNode;

    *headRef = head;
}

void insertAtEnd(struct node* head, int value){ struct node *newNode;
newNode = malloc(sizeof(struct node)); newNode->data = value;

newNode->next = NULL;

struct node *temp = head; while(temp->next != NULL){

temp = temp->next; }

temp->next = newNode; }

void deleteFromFront(struct node** headRef){ struct node* head =
*headRef;
head = head->next;
*headRef = head;

}

void deleteFromEnd(struct node* head){ struct node* temp = head;
while(temp->next->next!=NULL){

temp = temp->next; }
```

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```
temp->next = NULL; }

void deleteFromMiddle(struct node* head, int position){ struct node*
temp = head;
int i;
for(i=2; inext != NULL) {

temp = temp->next;

} }

temp->next = temp->next->n ext; }

int main() {
/* Initialize nodes */ struct node *head;
struct node *one = NULL; struct node *two = NULL; struct node *three
= NULL;

/* Allocate memory */
one = malloc(sizeof(struct node)); two = malloc(sizeof(struct node));
three = malloc(sizeof(struct node));

/* Assign data values */ one->data = 1; two->data = 2; three->data =
3;

/* Connect nodes */ one->next = two; two->next = three; three->next =
NULL;
```

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```
/* Save address of first node in head */ head = one;

display(head); // 1 --->2 --->3 ---> insertAtFront(&head, 4);

display(head); // 4 --->1 --->2 --->3 ---> deleteFromFront(&head);

display(head); // 1 --->2 --->3 ---> insertAtEnd(head, 5);

display(head); // 1 --->2 --->3 --->5 ---> deleteFromEnd(head);

display(head); // 1 --->2 --->3 --->

int position = 3;
insertAtMiddle(head, position, 10); display(head); // 1 --->2 --->10
--->3 --->

deleteFromMiddle(head, position);

display(head); // Output:

List elements are - 1 --->2 --->3 --->

List elements are - 4 --->1 --->2 --->3

List elements are - 1 --->2 --->3 --->

List elements are -

1 --->2 --->3 --->

}

--->
```

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```
1 --->2 --->3 --->5 --->

List elements are - 1 --->2 --->3 --->

List elements are -
1 --->2 --->10 --->3 --->

List elements are - 1 --->2 --->3 --->
```

5. Circular Linked List

```
#include <stdio.h> #include <string.h> #include <stdlib.h> #include
<stdbool.h>

struct node { int data;

int key;
struct node *next;

};
struct node *head = NULL;

struct node *current = NULL;

bool isEmpty() { return head == NULL;

}
int length() {

int length = 0;

//if list is empty if(head == NULL) {

return 0; }

current = head->next;
```

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```
while(current != head) { length++;

current = current->n ext; }

return length; }

//insert link at the first location

void insertFirst(int key, int data) {

//create a link
struct node *link = (struct node*) malloc(sizeof(struct node)); link->key =
key;
link->data = data;

if (isEmpty()) { head = link; head->next = head;

} else {
//point it to old first node link->next = head;

//point first to new first node

head = link; }

}

//delete first item

struct node * deleteFirst() { //save reference to first link

struct node *tempLink = head;

if(head->next == head) { head = NULL;
return tempLink;

}
//mark next to first link as first

head = head->next;

//return the deleted link return tempLink;
```

```
}
```

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```
//display the list

void printList() {
struct node *ptr = head;

printf("\n[ ");
//start from the beginning

if(head != NULL) {

while(ptr->next != ptr) { printf("(%d,%d) ",ptr- >key,ptr->data); ptr = ptr->
next;

} }

printf(" ]"); }

void main() { insertFirst(1,10); insertFirst(2,20); insertFirst(3,30);
insertFirst(4,1); insertFirst(5,40); insertFirst(6,56);

printf("Original List: "); //print list

printList();

while(!isEmpty()) {
struct node *temp = deleteFirst(); printf("\nDeleted value:"); printf(
"(%d,%d) ",temp->key,temp->data);

}

printf("\nList after deleting all items: ");

printList(); }
```

Output:

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```
Original List:
[ (6,56) (5,40) (4,1) (3,30) (2,20) ] Deleted value:(6,56)
Deleted value:(5,40)
Deleted value:(4,1)
Deleted value:(3,30)
Deleted value:(2,20)
Deleted value:(1,10)
List after deleting all items:
[]
```

6.
```
#include <stdio.h> #include <string.h> #include <stdlib.h> #include
<stdbool.h>

struct node { int data;

int key;

struct node *next;

struct node *prev; };

//this link always point to first Link

struct node *head = NULL;
//this link always point to last Link

struct node *last = NULL; struct node *current = NULL;

//is list empty

bool isEmpty() { return head == NULL;

}

int length() {
int length = 0; struct node *current;

for(current = head; current != NULL; current = current->next) { length++;
```

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```
}
return length;

}

//display the list in from first to last

void displayForward() { //start from the beginning

struct node *ptr = head; //navigate till the end of the list

printf("\n[ ");

while(ptr != NULL) {
printf("(%d,%d) ",ptr->k ey,ptr->data); ptr = ptr->next;

}
printf(" ]");

}

//display the list from last to first

void displayBackward() { //start from the last

struct node *ptr = last;
//navigate till the start of the list

printf("\n[ "); while(ptr != NULL) {

//print data
printf("(%d,%d) ",ptr->k ey,ptr->data);

//move to next item ptr = ptr ->prev;

} }
```

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```
//insert link at the first location

void insertFirst(int key, int data) {

//create a link
struct node *link = (struct node*) malloc(sizeof(struct node)); link->key =
key;
link->data = data;

if(isEmpty()) {
//make it the last link last = link;

} else {
//update first prev link head->prev = link;

}
//point it to old first link

link->next = head;

//point first to new first link

head = link; }

//insert link at the last location

void insertLast(int key, int data) {

//create a link
struct node *link = (struct node*) malloc(sizeof(struct node)); link->key =
key;
link->data = data;

if(isEmpty()) {
//make it the last link last = link;

} else {
//make link a new last link last->next = link;
```

```
//mark old last node as prev of new link

link->prev = last; }

//point last to new last node
```

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```
last = link; }

//delete first item

struct node* deleteFirst() { //save reference to first link

struct node *tempLink = head;

//if only one link if(head->next == NULL){

last = NULL; } else {

head->next->prev = NULL; }

head = head->next; //return the deleted link return tempLink;

}

//delete link at the last location

struct node* deleteLast() { //save reference to last link struct node *
tempLink = last;

//if only one link if(head->next == NULL) {

head = NULL; } else {

last->prev->next = NULL; }

last = last->prev;
```

```
//return the deleted link

return tempLink; }

//delete a link with given key

struct node* delete(int key) {
```

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```
//start from the first link struct node* current = head; struct node*
previous = NULL;

//if list is empty if(head == NULL) { return NULL;

}

//navigate through list while(current->key != key) {

//if it is last node

if(current->next == NULL) { return NULL;

} else {
//store reference to current link previous = current;

//move to next link

current = current->next; }

}

//found a match, update the link if(current == head) {

//change first to point to next link

head = head->next; } else {

//bypass the current link
```

```
current->prev->next = current->next; }

if(current == last) {
//change last to point to prev link last = current->prev;

} else {
current->next->prev = current->prev;

}
return current;

}
```

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```
bool insertAfter(int key, int newKey, int data) { //start from the first link
struct node *current = head;

//if list is empty if(head == NULL) {

return false; }

//navigate through while(current->key

//if it is last if(current->next == NULL) {

return false; } else {

} }

//move to current =

next link

current->next;

list

!= key) {
```

```
node

//create a link
struct node *newLink = (struct node*) malloc(sizeof(struct node)); newLink->
key = newKey;
newLink->data = data;

if(current == last) { newLink->next = NULL; last = newLink;

} else {
newLink->next = current->next; current->next->prev = newLink;

}

newLink->prev = current; current->next = newLink; return true;

}

void main() { insertFirst(1,10); insertFirst(2,20);
```


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```
insertFirst(3,30); insertFirst(4,1); insertFirst(5,40); insertFirst(6,56);

printf("\nList (First to Last): "); displayForward();

printf("\n");
printf("\nList (Last to first): "); displayBackward();

printf("\nList , after deleting first record: "); deleteFirst();
displayForward();

printf("\nList , after deleting last record: "); deleteLast();
displayForward();

printf("\nList , insert after key(4) : "); insertAfter(4,7, 13);
displayForward();

printf("\nList , after delete key(4) : "); delete(4);
displayForward();
```

```
}
```

Output:

```
List (First to Last):
[ (6,56) (5,40) (4,1) (3,30) (2,20) (1,10) ]
List (Last to first):
[ (1,10) (2,20) (3,30) (4,1) (5,40) (6,56) ]
List , after deleting first record:
[ (5,40) (4,1) (3,30) (2,20) (1,10) ]
List , after deleting last record:
[ (5,40) (4,1) (3,30) (2,20) ]
List , insert after key(4) :
[ (5,40) (4,1) (4,13) (3,30) (2,20) ]
```

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```
List , after delete key(4) :
[ (5,40) (4,13) (3,30) (2,20) ]
```

7. Topological Sort Program In C Language

```
#include <stdio.h> int main(){

    int i,j,k,n,a[10][10],indeg[10],flag[10],count=0;

printf("Enter the no of vertices:\n"); scanf("%d",&n);

printf("Enter the adjacency matrix:\n"); for(i=0;i<n;i++){

printf("Enter row %d\n",i+1); for(j=0;j<n;j++)

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

}

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

flag[i]=0; }
```

```
    for(i=0;i<n;i++)
        for(j=0;j<n;j++)
            indeg[i]=indeg[i]+a[j][i];

printf("\nThe topological order is:");

    while(count<n){
        for(k=0;k<n;k++){

if((indeg[k]==0) && (flag[k]==0)){ printf("%d ",(k+1));
flag [k]=1;

}
```

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```
      for(i=0;i<n;i++){
          if(a[i][k]==1)

} }

count++; }

return 0; }
```

Output:

Enter the no of vertices:
4
Enter the adjacency matrix: Enter row 1

0 110 Enter row 2 0 001 Enter row 3

```
indeg[k]--;
```

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0 001
Enter row 4
0 000
The topological order is:1 2 3 4

8. String Processing & Manipulation In C Language

```
#include <stdio.h> #include <string.h> int main(void)
{

//variable
char str[100], tmp; int i, len, mid;

//input
printf("Enter a string: "); gets(str);

//find number of characters len = strlen(str);
mid = len/2;

//reverse
for (i = 0; i < mid; i++) {

tmp = str[len - 1 - i]; str[len - 1 - i] = str[i]; str[i] = tmp;
```

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```
}
```

```
//output
printf("Reversed string: %s\n", str);

printf("End of code\n");

return 0; }
```

Output:

Enter a string: Hello World Reversed string: dlroW olleH End of code

9.Stacks & Queues Program In C Language i) Stack:

```
#include <stdio.h>
int MAXSIZE = 8;

int stack[8]; int top = -1; int isempty() { if(top == -1)

return 1;
```

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```
else return 0;

}
int isfull() {

if(top == MAXSIZE) return 1;

else return 0;

}
int peek() {

return stack[top]; }

int pop() { int data;
```

```
if(!isempty()) {
data = stack[top]; top = top - 1;
```

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```
return data; } else

{
printf("Could not retrieve data, Stack is empty.\n");

} }

int push(int data) { if(!isfull()) {

top = top + 1;

stack[top] = data; } else {

printf("Could not insert data, Stack is full.\n"); }

}
int main() {

// push items on to the stack push(3);
```

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```
push(5); push(9); push(1); push(12); push(15);
```

```
printf("Element at top of the stack: %d\n" ,peek()); printf("Elements: \n");
// print stack data

while(!isempty()) { int data = pop(); printf("%d\n",data);

}
printf("Stack full: %s\n" , isfull()?"true":"false"); printf("Stack empty: %s\n" ,
isempty()?"true":"false");

return 0; }
```

Output:

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Element at top of the stack: 15 Elements:
15
12

1
9
5
3
Stack full: false Stack empty: true

ii) Queue

```
#include <stdio.h> #include <string.h> #include <stdlib.h> #include <stdbool.h>

#define MAX 6
```

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```
int intArray[MAX]; int front = 0;
int rear = -1;
int itemCount = 0;

int peek() {
return intArray[front];

}

bool isEmpty() {
return itemCount == 0;

}

bool isFull() {
return itemCount == MAX;

}
```

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```
int size() {
return itemCount;

}

void insert(int data) {

if(!isFull()) {

if(rear == MAX-1) { rear = -1;

}

intArray[++rear] = data;
```

```
itemCount++; }

}
```

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```
int removeData() {
int data = intArray[front++];

if(front == MAX) { front = 0;

}

itemCount--;

return data; }

int main() {
/* insert 5 items */ insert(3); insert(5); insert(9);
```

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```
insert(1); insert(12);

// front : 0
// rear : 4
// ------------------
// index : 0 1 2 3 4
```

// ------------------
// queue : 3 5 9 1 12 insert(15);

// front : 0
// rear : 5
// --------------------- //index:01234 5
// ---------------------
// queue : 3 5 9 1 12 15

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```
if(isFull()) {
printf("Queue is full!\n");

}

// remove one item
int num = removeData();

printf("Element removed: %d\n",num); // front : 1
// rear : 5
// -------------------

//index:1234 5
// -------------------
// queue : 5 9 1 12 15

// insert more items
```

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insert(16);

// front : 1
// rear : -1
// ---------------------- //index:0 1234 5
// ----------------------
// queue : 16 5 9 1 12 15

// As queue is full, elements will not be inserted. insert(17);
insert(18);

// ---------------------- //index:0 1234 5
// ----------------------
// queue : 16 5 9 1 12 15

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printf("Element at front: %d\n",peek());

printf("----------------------\n"); printf("index : 5 4 3 2 1 0\n"); printf("----------------------\n");
printf("Queue: ");

while(!isEmpty()) {
int n = removeData(); printf("%d ",n);

} }

Output:

Queue is full! Element removed: 3 Element at front: 5 ----------------------

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index : 5 4 3 2 1 0

Queue: 5 9 1 12 15 16

10. Sorting & Searching Techniques

i) Sorting

```
/*
* C program to accept N numbers and arrange them in an ascending order */

#include <stdio.h> void main()
{

int i, j, a, n, number[30]; printf("Enter the value of N \n");
```

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

printf("Enter the numbers \n"); for (i = 0; i < n; ++i)

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

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

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

```
if (number[i] > number[j]) {
```

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```
a = number[i]; number[i] = number[j]; number[j] = a;

}

}

}
printf("The numbers arranged in ascending order are given below \n");

for (i = 0; i < n; ++i) printf("%d\n", number[i]);

}
```

Output:

Enter the value of N: 6

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Enter the numbers 3
78
90

456
780
200
The numbers arranged in ascending order are given below 3

78
90
200
456
780

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ii) Searching

1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24.

```
#include <stdio.h>

int main() {

int array[100], search, c, n;
printf("Enter number of elements in array\n");

scanf("%d", &n);

printf("Enter %d integer(s)\n" , n);

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

printf("Enteranumbertosearch\n"); scanf("%d", &search) ;

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

if (array[c] == search)  {

/* If required element is found */
```

```
printf("%d is present at location %d.\n", search, c+1);

break; }
```

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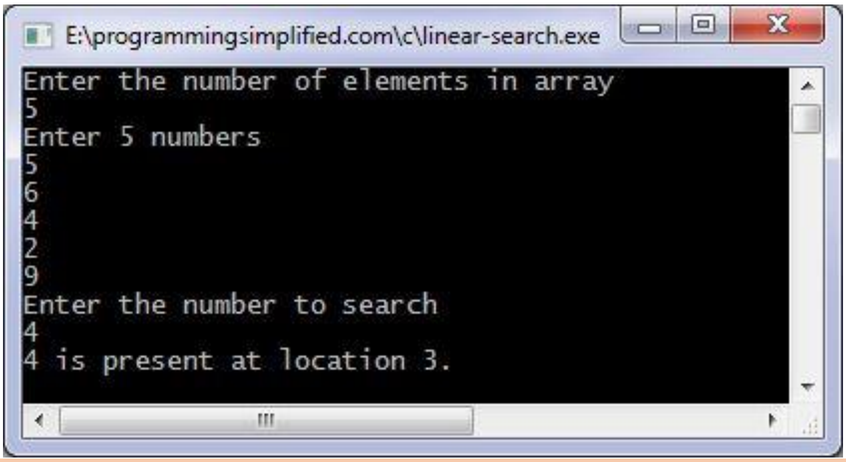
```
25.}
26.if (c == n)
27.printf("%d isn't present in the array.\n", search);

28.
29. return 0; 30.}
```

Output:

11. Dynamic Programming

```
#include<stdio.h>

int max(int a, int b) { return (a > b)? a : b; }
```



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```
int knapSack(int W, int wt[], int val[], int n) {

int i, w;
int K[n+1][W+1];

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

for (w = 0; w <= W; w++) {

if (i==0 || w==0) K[i][w] = 0;

else if (wt[i-1] <= w)
K[i][w] = max(val[i-1] + K[i-1][w-wt[i-1]], K[i-1][w]);

else
K[i][w] = K[i-1][w];
```

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```
} }

return K[n][W]; }

int main()
{
int i, n, val[20], wt[20], W;

printf("Enter number of items:"); scanf("%d", &n);

printf("Enter value and weight of items:\n"); for(i = 0;i < n; ++i){

scanf("%d%d", &val[i], &wt[i]); }
```

printf("Enter size of knapsack:"); scanf("%d", &W);

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printf("%d", knapSack(W, wt, val, n));

return 0; }

Output:

Enter number of items:3
Enter value and weight of items:
100 20
50 10
150 30
Enter size of knapsack:50
250

12. Greedy Algorithm In C Language #include <stdio.h>
int main () {

int num_denominations, coin_list[100], use_these[100], i, owed;

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printf("Enter number of denominations : "); scanf("%d", &num_denominations);

printf("\nEnter the denominations in descending order: ");

for(i=0; i< num_denominations; i++) { scanf("%d", &coin_list[i]);

// use_these[i] = 0; }

printf("\nEnter the amount owed : "); scanf("%d", &owed);
for(i=0; i < num_denominations; i++) {

use_these[i] = owed / coin_list[i];

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owed %= coin_list[i]; }

printf("\nSolution: \n");
for(i=0; i < num_denominations; i++) {

printf("%dx%d ", coin_list[i], use_these[i]); }

}

Output:

```
~/cpe/greedy_coin_change
sandeepa@sn ~/cpe/greedy_coin_change
$ ./a.exe
Enter number of denominations : 3

Enter the denominations in descending order: 10 5 1

Enter the amount owed : 17

Solution:
10x1 5x1 1x2
sandeepa@sn ~/cpe/greedy_coin_change
$ ./a.exe
Enter number of denominations : 5

Enter the denominations in descending order: 100
50 20 5 1

Enter the amount owed : 78

Solution:
100x0 50x1 20x1 5x1 1x3
sandeepa@sn ~/cpe/greedy_coin_change
$ |
```

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13. String Matching Program In C Language

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

int length(char x[]) {

int i; for(i=0;x[i]!='\0';i++) {}
return i;

}
void main() {

char s[20],p[20];
```

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```
int i,l,count=0; clrscr();

printf("\n enter Your String = "); scanf("%s",s);
printf("enter the string to be matched = "); scanf("%s",p );

l=length(p);

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

if(s[i]==p[count] ) count++;
```

else {

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count=0; }

if (count == l) {

printf("Substring %s found in the given string",p); break;

} }if(count!=l)

printf("not found"); getch();

}

Output:

```
 enter Your String   =  110101010100011
enter the string to be matched = 1010
Substring 1010 found in the given string
 enter Your String   =  11001010101010101011010101010101
enter the string to be matched = 101
Substring 101 found in the given string
```

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14. Divide & Conquer Program In C language

```
#include <stdio.h>

#define max 10

int a[11] = { 10, 14, 19, 26, 27, 31, 33, 35, 42, 44, 0 }; int b[10];

void merging(int low, int mid, int high) { int l1, l2, i;

for(l1 = low, l2 = mid + 1, i = low; l1 <= mid && l2 <= high; i++) { if(a[l1] <= a[l2])

b[i] = a[l1++]; else
```


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```
b[i] = a[l2++]; }

while(l1 <= mid) b[i++] = a[l1++];

while(l2 <= high) b[i++] = a[l2++];

for(i = low; i <= high; i++) a[i] = b[i];

}

void sort(int low, int high) { int mid;
```

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```
if(low < high) {
mid = (low + high) / 2; sort(low, mid); sort(mid+1, high); merging(low, mid, high);

} else { return;

} }

int main() { int i;

printf("List before sorting\n");
```

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```
for(i = 0; i <= max; i++) printf("%d ", a[i]);

sort(0, max);

printf("\nList after sorting\n");

for(i = 0; i <= max; i++) printf("%d ", a[i]);

}
```

Output:

List before sorting
10 14 19 26 27 31 33 35 42 44 0 List after sorting
0 10 14 19 26 27 31 33 35 42 44

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15. Disjoint sets Program In C Language

```
// A union-find algorithm to detect cycle in a graph #include <stdio.h>
#include <stdlib.h>
#include <string.h>

// a structure to represent an edge in graph struct Edge
{

int src, dest; };

// a structure to represent a graph struct Graph
{
```

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```
// V-> Number of vertices, E-> Number of edges int V, E;

// graph is represented as an array of edges

struct Edge* edge; };

// Creates a graph with V vertices and E edges struct Graph* createGraph(int V, int E)
{

struct Graph* graph =
(struct Graph*) malloc( sizeof(struct Graph) );

graph->V = V; graph->E = E;
```

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```
graph->edge =
(struct Edge*) malloc( graph->E * sizeof( struct Edge ) );

return graph; }

// A utility function to find the subset of an element i int find(int parent[], int i)
{

if (parent[i] == -1) return i;

return find(parent, parent[i]); }

// A utility function to do union of two subsets
```

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```
void Union(int parent[], int x, int y) {

int xset = find(parent, x); int yset = find(parent, y); if(xset!=yset){

parent[xset] = yset; }

}
```

```
// The main function to check whether a given graph contains // cycle or not
int isCycle( struct Graph* graph )
{

// Allocate memory for creating V subsets
int *parent = (int*) malloc( graph->V * sizeof(int) );
```


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```
// Initialize all subsets as single element sets memset(parent, -1, sizeof(int) * graph->V);

// Iterate through all edges of graph, find subset of both // vertices of every edge, if both
subsets are same, then // there is cycle in graph.
for(int i = 0; i < graph->E; ++i)

{
int x = find(parent, graph->edge[i].src); int y = find(parent, graph->edge[i].dest);

if (x == y) return 1;
```


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```
Union(parent, x, y); }

return 0; }

// Driver program to test above functions int main()
{
```

```
/* Let us create following graph 0

|\
|\ 1-----2 */

int V = 3, E = 3;
struct Graph* graph = createGraph(V, E);
```


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```
// add edge 0-1 graph->edge[0].src = 0; graph->edge[0].dest = 1;

// add edge 1-2 graph->edge[1].src = 1; graph->edge[1].dest = 2;

// add edge 0-2 graph->edge[2].src = 0; graph->edge[2].dest = 2;

if (isCycle(graph))
printf( "graph contains cycle" );
```


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```
else
printf( "graph doesn't contain cycle" );

return 0; }
```

Output:

graph contains cycle

16. Computational Geometry

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

struct Point {

int x, y; };
```

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```
// To find orientation of ordered triplet (p, q, r). // The function returns following values
// 0 --> p, q and r are colinear
// 1 --> Clockwise

// 2 --> Counterclockwise
int orientation(Point p, Point q, Point r) {

int val = (q.y - p.y) * (r.x - q.x) - (q.x - p.x) * (r.y - q.y);

if (val == 0) return 0; // colinear

return (val > 0)? 1: 2; // clock or counterclock wise }
```

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```
// Prints convex hull of a set of n points. void convexHull(Point points[], int n)
{

// There must be at least 3 points if (n < 3) return;

// Initialize Result vector<Point> hull;

// Find the leftmost point int l = 0;
for (int i = 1; i < n; i++)

if (points[i].x < points[l].x) l = i;
```

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```
// Start from leftmost point, keep moving counterclockwise // until reach the start point again.
This loop runs O(h)
// times where h is number of points in result or output.
int p = l, q;

do {

// Add current point to result hull.push_back(points[p]);

// Search for a point 'q' such that orientation(p, x,
// q) is counterclockwise for all points 'x'. The idea
// is to keep track of last visited most counterclock-
// wise point in q. If any point 'i' is more counterclock- // wise than q, then update q.
q = (p+1)%n;
```

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

// If i is more counterclockwise than current q, then // update q
if (orientation(points[p], points[i], points[q]) == 2)

q = i; }
```

- // Now q is the most counterclockwise with respect to p
- // Set p as q for next iteration, so that q is added to
- // result 'hull'

```
p = q;

} while (p != l); // While we don't come to first point
```

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```
// Print Result
for (int i = 0; i < hull.size(); i++)

cout << "(" << hull[i].x << ", " << hull[i].y << ")\n";

}
// Driver program to test above functions

int main() {

Point points[] = {{0, 3}, {2, 2}, {1, 1}, {2, 1}, {3, 0}, {0, 0}, {3, 3}};

int n = sizeof(points)/sizeof(points[0]); convexHull(points, n);
return 0;

}
```

Output:

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The output is points of the convex hull. (0, 3)
(0, 0)
(3, 0)

(3, 3)
17. // Program to print BFS traversal from a given // source vertex. BFS(int s) traverses vertices
// reachable from s.

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

using namespace std;

// This class represents a directed graph using // adjacency list representation
```


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```
class Graph {

int V; // No. of vertices

// Pointer to an array containing adjacency // lists
list<int> *adj;

public:
Graph(int V); // Constructor
```

```
// function to add an edge to graph void addEdge(int v, int w);

// prints BFS traversal from a given source s void BFS(int s);

};
```

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```
Graph::Graph(int V) {

this->V = V;

adj = new list<int>[V]; }

void Graph::addEdge(int v, int w) {

adj[v].push_back(w); // Add w to v’s list. }

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

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```
// Mark all the vertices as not visited bool *visited = new bool[V];
for(int i = 0; i < V; i++)

visited[i] = false;

// Create a queue for BFS list<int> queue;
```

```
// Mark the current node as visited and enqueue it visited[s] = true;
queue.push_back(s);

// 'i' will be used to get all adjacent // vertices of a vertex list<int>::iterator i;
```

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```
while(!queue.empty()) {

// Dequeue a vertex from queue and print it s = queue.front();
cout << s << " ";
queue.pop_front();

// Get all adjacent vertices of the dequeued // vertex s. If a adjacent has not been visited, //
then mark it visited and enqueue it
for (i = adj[s].begin(); i != adj[s].end(); ++i)
{

if (!visited[*i]) {
```

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```
visited[*i] = true;

queue.push_back(*i); }

} }
```

```
}

// Driver program to test methods of graph class int main()
{

// Create a graph given in the above diagram Graph g(4);
g.addEdge(0, 1);
g.addEdge(0, 2);

g.addEdge(1, 2);
```


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```
g.addEdge(2, 0); g.addEdge(2, 3); g.addEdge(3, 3);

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

g.BFS(2);

return 0; }
```

Output

Following is Breadth First Traversal (starting from vertex 2) 2031

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18. #include <stdio.h>

```
#include <stdlib.h>

struct node { int data;

struct node* left;

struct node* right; };

struct node* createNode(value){
struct node* newNode = malloc(sizeof(struct node)); newNode->data = value;
newNode->left = NULL;
newNode->right = NULL;
```

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```
return newNode; }

struct node* insertLeft(struct node *root, int value) { root->left = createNode(value);
return root->left;

}

struct node* insertRight(struct node *root, int value){ root->right = createNode(value);
return root->right;

}

int main(){
```

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```
struct node *root = createNode(1); insertLeft(root, 2); insertRight(root, 3);

printf("The elements of tree are %d %d %d", root->data, root->left->data, root->right->data);
}
```

Output - 1 2 3

19. Dijkstra's Algorithm

```
#include<stdio.h> #include<conio.h> #define INFINITY 9999 #define MAX 10

void dijkstra(int G[MAX][MAX],int n,int startnode);
```

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```
int main() {

int G[MAX][MAX],i,j,n,u;
printf("Enter no. of vertices:"); scanf("%d",&n);
printf("\nEnter the adjacency matrix:\n");

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

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

printf("\nEnter the starting node:"); scanf("%d",&u);
dijkstra(G,n,u);
```

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return 0; }

void dijkstra(int G[MAX][MAX],int n,int startnode) {

int cost[MAX][MAX],distance[MAX],pred[MAX]; int
visited[MAX],count,mindistance,nextnode,i,j;

//pred[] stores the predecessor of each node //count gives the number of nodes seen so far
//create the cost matrix
for(i=0;i<n;i++)

for(j=0;j<n;j++) if(G[i][j]==0)

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cost[i][j]=INFINITY; else

cost[i][j]=G[i][j];

//initialize pred[],distance[] and visited[] for(i=0;i<n;i++)
{

distance[i]=cost[startnode][i]; pred[i]=startnode; visited[i]=0;

}

```
distance[startnode]=0; visited[startnode]=1; count=1;
```

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```
while(count<n-1) {

mindistance=INFINITY;

//nextnode gives the node at minimum distance for(i=0;i<n;i++)

if(distance[i]<mindistance&&!visited[i]) {

mindistance=distance[i];

nextnode=i; }

//check if a better path exists through nextnode visited[nextnode]=1;
```

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```
for(i=0;i<n;i++) if(!visited[i])

if(mindistance+cost[nextnode][i]<distance[i]) {

distance[i]=mindistance+cost[nextnode][i];

pred[i]=nextnode; }
```

```
count++; }

//print the path and distance of each node for(i=0;i<n;i++)

if(i!=startnode) {

printf("\nDistance of node%d=%d",i,distance[i]);
```

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```
printf("\nPath=%d",i);

j=i; do {

j=pred[j];

printf("<-%d",j); }while(j!=startnode);

} }
```

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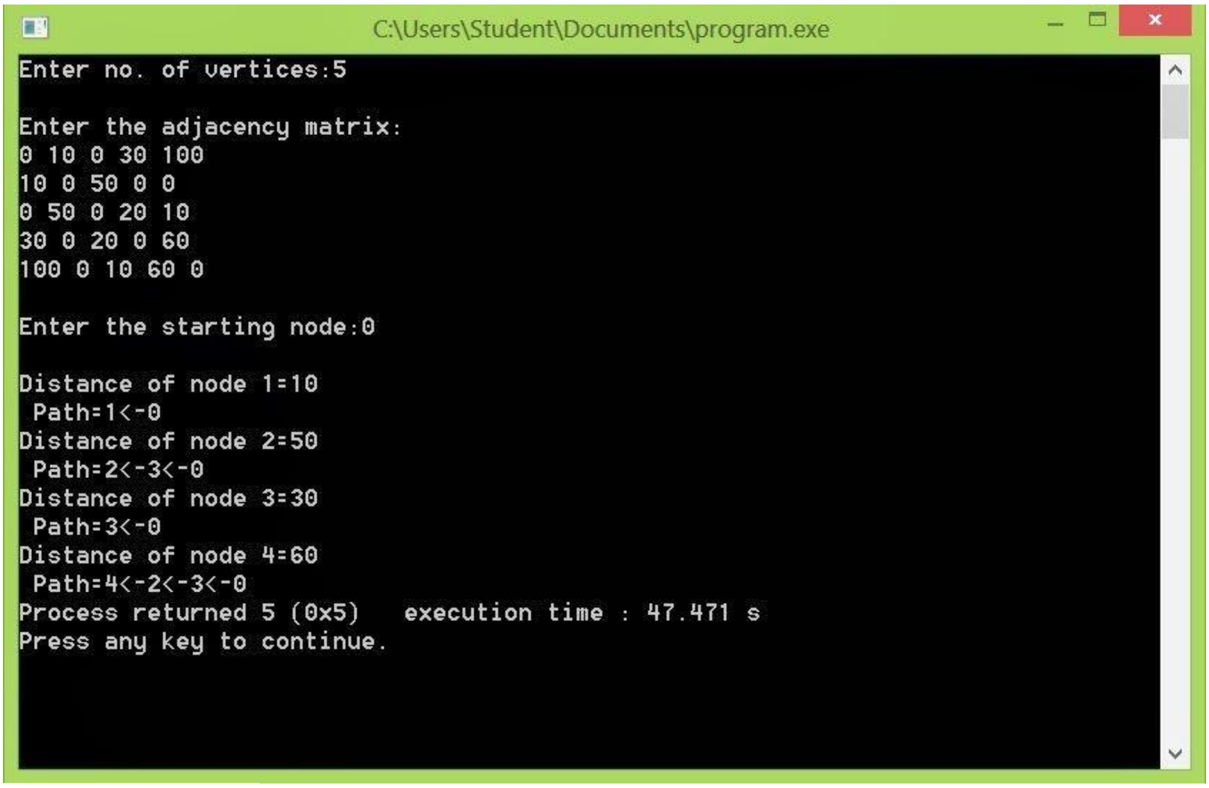
Output:

20. Prims Algorithm

```
// A C / C++ program for Prim's Minimum
// Spanning Tree (MST) algorithm. The program is // for adjacency matrix representation of
```

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



```
C:\Users\Student\Documents\program.exe
Enter no. of vertices:5

Enter the adjacency matrix:
0 10 0 30 100
10 0 50 0 0
0 50 0 20 10
30 0 20 0 60
100 0 10 60 0

Enter the starting node:0

Distance of node 1=10
 Path=1<-0
Distance of node 2=50
 Path=2<-3<-0
Distance of node 3=30
 Path=3<-0
Distance of node 4=60
 Path=4<-2<-3<-0
Process returned 5 (0x5)   execution time : 47.471 s
Press any key to continue.
```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```
#include<stdbool.h>
// Number of vertices in the graph #define V 5

// A utility function to find the vertex with
// minimum key value, from the set of vertices // not yet included in MST
int minKey(int key[], bool mstSet[])
{
// Initialize min value
int min = INT_MAX, min_index;
```

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

min = key[v], min_index = v;
```

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```
return min_index; }

// A utility function to print the
// constructed MST stored in parent[]
int printMST(int parent[], int n, int graph[V][V]) {
printf("Edge \tWeight\n");
for (int i = 1; i < V; i++)

printf("%d - %d \t%d \n", parent[i], i, graph[i][parent[i]]); }

// Function to construct and print MST for // a graph represented using adjacency
```

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```
// matrix representation
void primMST(int graph[V][V]) {

// Array to store constructed MST
int parent[V];
// Key values used to pick minimum weight edge in cut int key[V];
// To represent set of vertices not yet included in MST bool mstSet[V];
```

// Initialize all keys as INFINITE for (int i = 0; i < V; i++)

key[i] = INT_MAX, mstSet[i] = false;

// Always include first 1st vertex in MST.

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// Make key 0 so that this vertex is picked as first vertex. key[0] = 0;
parent[0] = -1; // First node is always root of MST

// The MST will have V vertices
for (int count = 0; count < V-1; count++) {

// Pick the minimum key vertex from the // set of vertices not yet included in MST int u = minKey(key, mstSet);

// Add the picked vertex to the MST Set mstSet[u] = true;

// Update key value and parent index of

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// the adjacent vertices of the picked vertex. // Consider only those vertices which are not // yet included in MST
for (int v = 0; v < V; v++)

```
// graph[u][v] is non zero only for adjacent vertices of m
// mstSet[v] is false for vertices not yet included in MST
// Update the key only if graph[u][v] is smaller than key[v]
if (graph[u][v] && mstSet[v] == false && graph[u][v] < key[v])

parent[v] = u, key[v] = graph[u][v]; }

// print the constructed MST

printMST(parent, V, graph); }
```


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```
// driver program to test above function int main()
{
/* Let us create the following graph

23 (0)--(1)--(2) |/\|
6| 8/ \5 |7 |/ \| (3)-------(4)

9 */
int graph[V][V] = {{0, 2, 0, 6, 0},

{2, 0, 3, 8, 5},
```

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```
{0, 3, 0, 0, 7}, {6, 8, 0, 0, 9}, {0, 5, 7, 9, 0}};

// Print the solution primMST(graph);

return 0; }
```

Output:
Edge Weight 0-1 2

1-2 3
0-3 6
1-4 5