QUESTION:

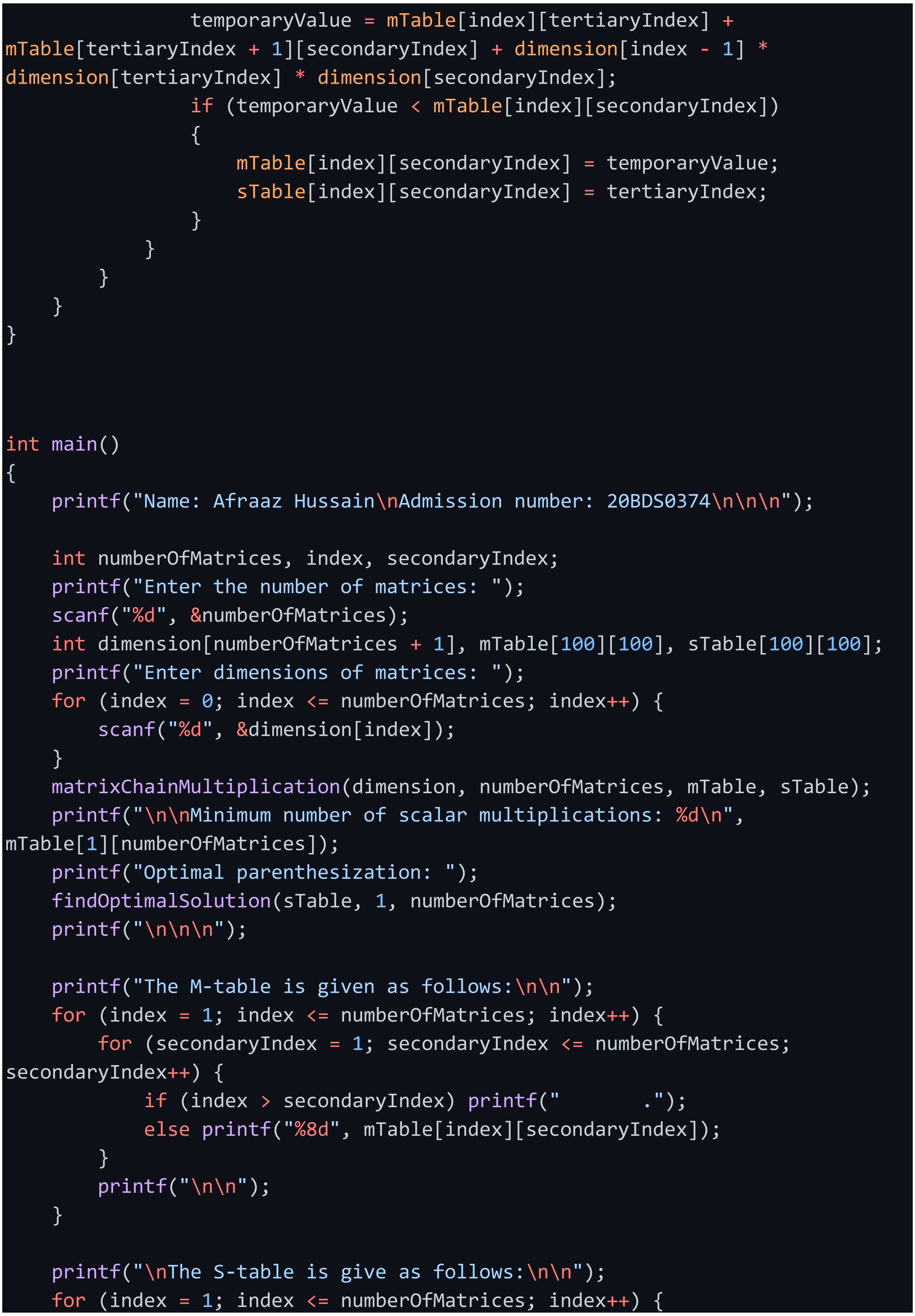
Design an algorithm and implement matrix chain multiplication problem using dynamic programming approach.

PSEUDOCODE:

```
function findOptimalSolution(sTable, index, secondaryIndex):
    if index = secondaryIndex print("A" + index)
    else:
        print("(")
        findOptimalSolution(sTable, index, sTable[index][secondaryIndex])
        findOptimalSolution(sTable, sTable[index][secondaryIndex] + 1,
secondaryIndex)
        print(")")

function matrixChainMultiplication(dimension, numberOfMatrices, mTable,
sTable):
    for index from 1 to numberOfMatrices mTable[index][index] = 0

    for element from 2 to numberOfMatrices:
        for index from 1 to numberOfMatrices - element + 1:
            secondaryIndex = index + element - 1
            mTable[index][secondaryIndex] = maxValueOfIntDataType
            for tertiaryIndex from index to secondaryIndex - 1:
                temporaryValue = mTable[index][tertiaryIndex] +
mTable[tertiaryIndex + 1][secondaryIndex] + dimension[index - 1] *
dimension[tertiaryIndex] * dimension[secondaryIndex]
                if temporaryValue < mTable[index][secondaryIndex]:
                    mTable[index][secondaryIndex],
sTable[index][secondaryIndex] = temporaryValue, tertiaryIndex

function main():
    numberOfMatrices = input()
    dimension[numberOfMatrices] = input()
    initialize sTable[100][100], mTable[100][100]

    matrixChainMultiplication(dimension, numberOfMatrices, mTable, sTable)
    print("Minimum number of scalar multiplications:
mTable[1][numberOfMatrices]")
    print("Optimal solution: findOptimalSolution(sTable, 1,
numberOfMatrices)")

    print("M table: ")
    for index from 1 to numberOfMatrices:
        for secondaryIndex from 1 to numberOfMatrices:
            print(mTable[index][secondaryIndex])
        newLine;

    print("S table: ")
    for index rom 1 to numberOfMatrices:
     for secondaryIndex from 1 to numberOfMatrices:
        print(sTable[index][secondaryIndex])
    newLine;
```

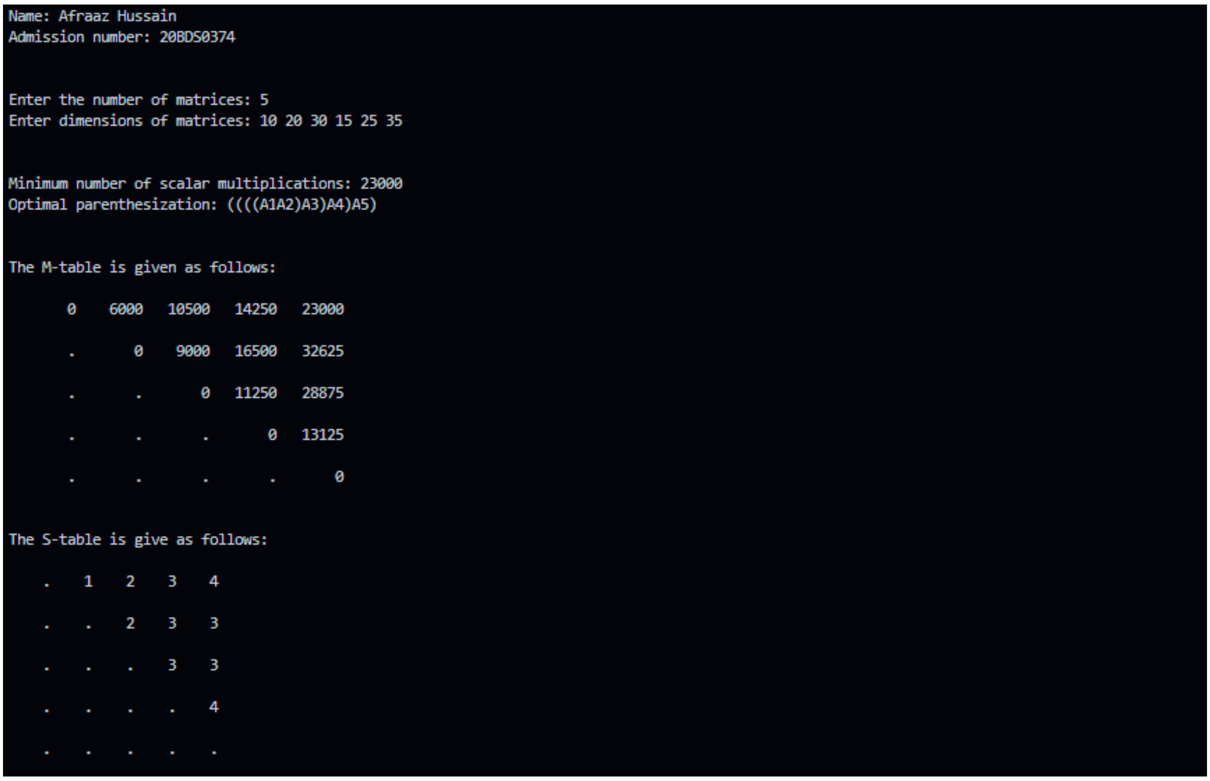
CODE:

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



void findOptimalSolution(int sTable[][100], int index, int secondaryIndex) {
    if (index == secondaryIndex) printf("A%d", index);
    else
    {
        printf("(");
        findOptimalSolution(sTable, index, sTable[index][secondaryIndex]);
        findOptimalSolution(sTable, sTable[index][secondaryIndex] + 1,
secondaryIndex);
        printf(")");
    }
}

void matrixChainMultiplication(int dimension[], int numberOfMatrices, int
mTable[][100], int sTable[][100])
{
    int index, secondaryIndex, tertiaryIndex, element, temporaryValue;
    for (index = 1; index <= numberOfMatrices; index++) mTable[index][index] =
0;

    for (element = 2; element <= numberOfMatrices; element++)
    {
        for (index = 1; index <= numberOfMatrices - element + 1; index++)
        {
            secondaryIndex = index + element - 1;
            mTable[index][secondaryIndex] = INT_MAX;
            for (tertiaryIndex = index; tertiaryIndex <= secondaryIndex - 1;
tertiaryIndex++)
            {
```



```
                temporaryValue = mTable[index][tertiaryIndex] +
mTable[tertiaryIndex + 1][secondaryIndex] + dimension[index - 1] *
dimension[tertiaryIndex] * dimension[secondaryIndex];
                if (temporaryValue < mTable[index][secondaryIndex])
                {
                    mTable[index][secondaryIndex] = temporaryValue;
                    sTable[index][secondaryIndex] = tertiaryIndex;
                }
            }
        }
    }
}



int main()
{
    printf("Name: Afraaz Hussain\nAdmission number: 20BDS0374\n\n\n");

    int numberOfMatrices, index, secondaryIndex;
    printf("Enter the number of matrices: ");
    scanf("%d", &numberOfMatrices);
    int dimension[numberOfMatrices + 1], mTable[100][100], sTable[100][100];
    printf("Enter dimensions of matrices: ");
    for (index = 0; index <= numberOfMatrices; index++) {
        scanf("%d", &dimension[index]);
    }
    matrixChainMultiplication(dimension, numberOfMatrices, mTable, sTable);
    printf("\n\nMinimum number of scalar multiplications: %d\n",
mTable[1][numberOfMatrices]);
    printf("Optimal parenthesization: ");
    findOptimalSolution(sTable, 1, numberOfMatrices);
    printf("\n\n\n");

    printf("The M-table is given as follows:\n\n");
    for (index = 1; index <= numberOfMatrices; index++) {
        for (secondaryIndex = 1; secondaryIndex <= numberOfMatrices;
secondaryIndex++) {
            if (index > secondaryIndex) printf("       .");
            else printf("%8d", mTable[index][secondaryIndex]);
        }
        printf("\n\n");
    }

    printf("\nThe S-table is give as follows:\n\n");
    for (index = 1; index <= numberOfMatrices; index++) {
        for (secondaryIndex = 1; secondaryIndex <= numberOfMatrices;
secondaryIndex++) {
            if (index >= secondaryIndex) printf("    .");
            else printf("%5d", sTable[index][secondaryIndex]);
        }
        printf("\n\n");
    }
    return 0;
}
```

OUTPUT:



```
Name: Afraaz Hussain
Admission number: 20BDS0374


Enter the number of matrices: 5
Enter dimensions of matrices: 10 20 30 15 25 35


Minimum number of scalar multiplications: 23000
Optimal parenthesization: ((((A1A2)A3)A4)A5)


The M-table is given as follows:

       0    6000   10500   14250   23000

       .       0    9000   16500   32625

       .       .       0   11250   28875

       .       .       .       0   13125

       .       .       .       .       0


The S-table is give as follows:

    .    1    2    3    4

    .    .    2    3    3

    .    .    .    3    3

    .    .    .    .    4

    .    .    .    .    .
```

QUESTION:

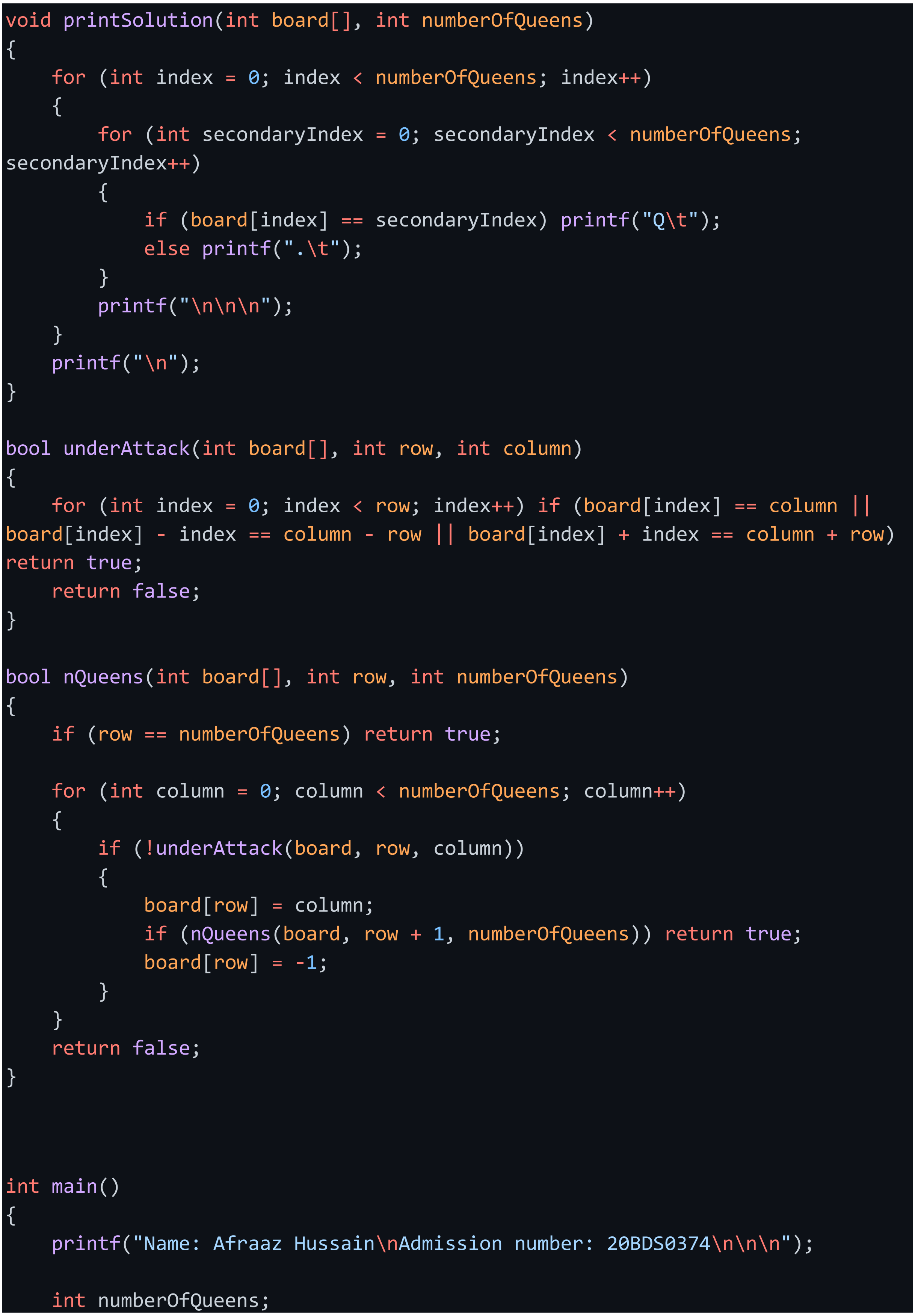
Implement N-Queens problem using backtracking technique.

PSEUDOCODE:

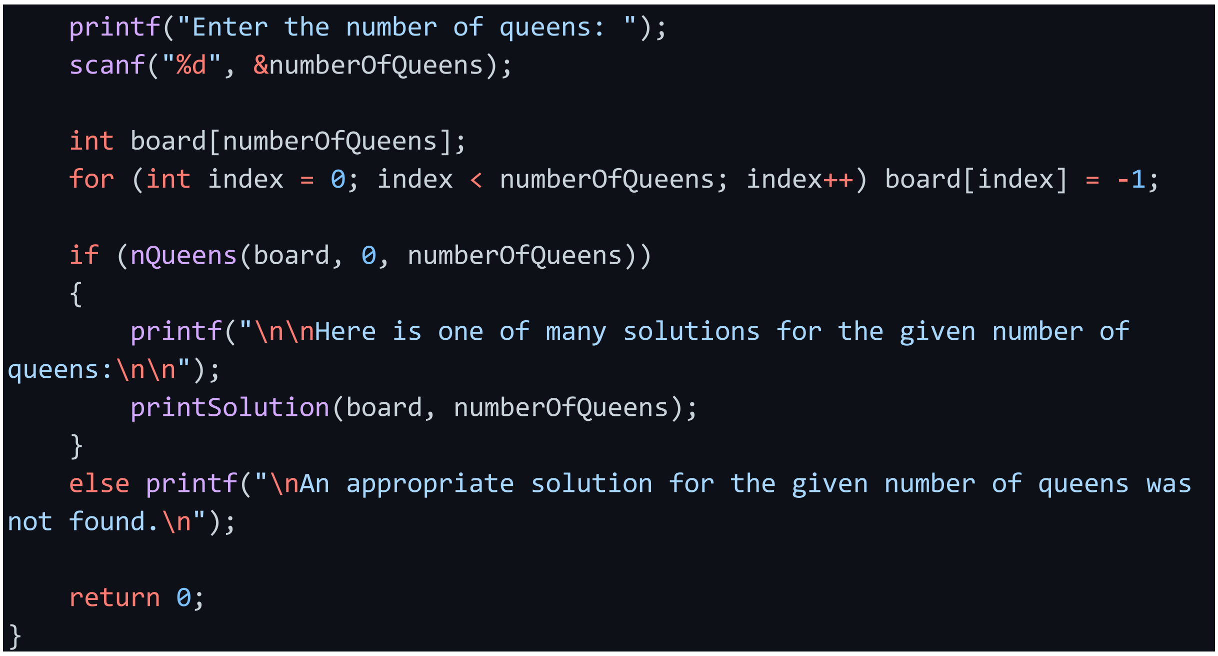
```
function printSolution(board, numberOfQueens):
    for row from 0 to numberOfQueens:
        for column from 0 to numberOfQueens:
            print(board[row][column])
        print(newLine)

function underAttack(board, row, column):
    for index from 0 to row:
        if any of:
            board[index] == column or
            board[index] - index == column - row or
            board[index] + index == column + row

            then: return true
        return false

function nQueens(board, row, numberOfQueens):
    if row is numberOfQueens: return true
    for column from 0 to numberOfQueens:
        if not underAttack(board, row, column):
            board[row] = column
            if nQueens(board, row + 1, numberOfQueens): return true
            board[row] = -1
    return false

function main():
    numberOfQueens = input()
    board[numberOfQueens][numberOfQueens] = -1

    if nQueens(board, 0, numberOfQueens) printSolution(board, numberOfQueens)
    else print("No solution")

    return
```

CODE:

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

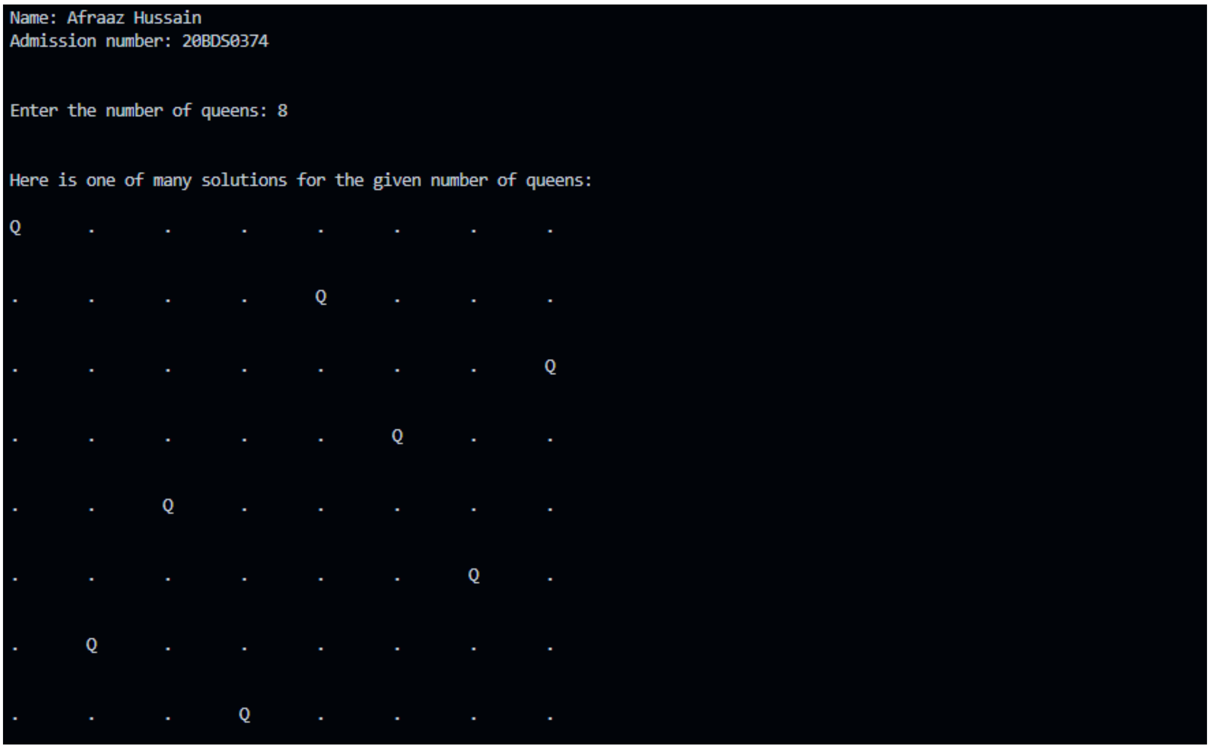


```
void printSolution(int board[], int numberOfQueens)
{
    for (int index = 0; index < numberOfQueens; index++)
    {
        for (int secondaryIndex = 0; secondaryIndex < numberOfQueens;
secondaryIndex++)
        {
            if (board[index] == secondaryIndex) printf("Q\t");
            else printf(".\t");
        }
        printf("\n\n\n");
    }
    printf("\n");
}

bool underAttack(int board[], int row, int column)
{
    for (int index = 0; index < row; index++) if (board[index] == column ||
board[index] - index == column - row || board[index] + index == column + row)
return true;
    return false;
}

bool nQueens(int board[], int row, int numberOfQueens)
{
    if (row == numberOfQueens) return true;

    for (int column = 0; column < numberOfQueens; column++)
    {
        if (!underAttack(board, row, column))
        {
            board[row] = column;
            if (nQueens(board, row + 1, numberOfQueens)) return true;
            board[row] = -1;
        }
    }
    return false;
}



int main()
{
    printf("Name: Afraaz Hussain\nAdmission number: 20BDS0374\n\n\n");

    int numberOfQueens;
```



```
    printf("Enter the number of queens: ");
    scanf("%d", &numberOfQueens);

    int board[numberOfQueens];
    for (int index = 0; index < numberOfQueens; index++) board[index] = -1;

    if (nQueens(board, 0, numberOfQueens))
    {
        printf("\n\nHere is one of many solutions for the given number of
queens:\n\n");
        printSolution(board, numberOfQueens);
    }
    else printf("\nAn appropriate solution for the given number of queens was
not found.\n");

    return 0;
}
```

OUTPUT:



```
Name: Afraaz Hussain
Admission number: 20BDS0374


Enter the number of queens: 8


Here is one of many solutions for the given number of queens:

Q       .       .       .       .       .       .       .

.       .       .       .       Q       .       .       .

.       .       .       .       .       .       .       Q

.       .       .       .       .       Q       .       .

.       .       Q       .       .       .       .       .

.       .       .       .       .       .       Q       .

.       Q       .       .       .       .       .       .

.       .       .       Q       .       .       .       .
```

AFRAAZ HUSSAIN
20BDS0374
DESIGN AND ANALYSIS OF ALGORITHMS
LAB ASSESSMENT 3

QUESTION:

Design an algorithm using Naïve approach to check whether given pattern P is plagiarized in given Text T.

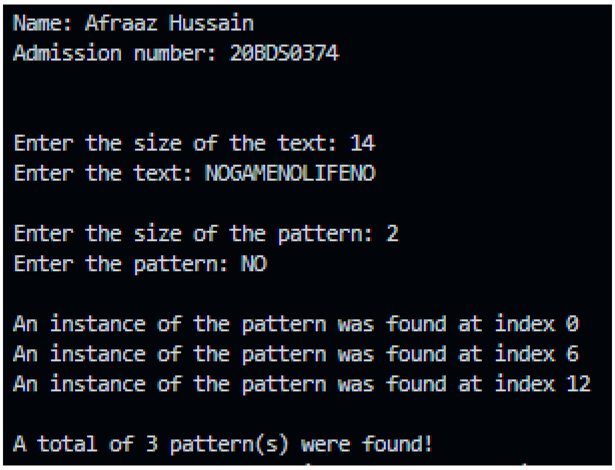
PSEUDOCODE:

```
function naiveMethod():
    textSize, text, patternSize, pattern = input()
    patternCount = 0

    for index from 0 to textSize:
        counter = 0
        for secondaryIndex from 0 to patternSize:
            if pattern[secondaryIndex] = text[index + secondaryIndex]
counter++
            else break

        if counter = patternSize:
            print index of pattern
            patternCount++

    if patternCount = 0 print("No pattern was found!")
    else print the number of patterns found

function main():
    naiveMethod()
```

CODE:

```
#include <stdio.h>



void naiveMethod()
{
    int textSize, patternSize, index, secondaryIndex, counter, patternCount =
0;
    printf("Enter the size of the text: ");
    scanf("%d", &textSize);
    char text[textSize + 1];
    printf("Enter the text: ");
    scanf("%s", &text);

    printf("\nEnter the size of the pattern: ");
    scanf("%d", &patternSize);
    char pattern[patternSize];
    printf("Enter the pattern: ");
    scanf("%s", &pattern);

    for (index = 0; index < textSize; index++)
    {
        counter = 0;
        for (secondaryIndex = 0; secondaryIndex < patternSize;
secondaryIndex++)
        {
            if (pattern[secondaryIndex] == text[index + secondaryIndex])
counter++;
            else break;
        }

        if (counter == patternSize)
        {
            printf("\nAn instance of the pattern was found at index %d",
index);
            patternCount++;
        }
    }

    if (patternCount == 0) printf("\nThe given pattern was not found in the
string provided.");
    else printf("\n\nA total of %d pattern(s) were found!", patternCount);
}



int main()
{
    printf("Name: Afraaz Hussain\nAdmission number: 20BDS0374\n\n\n");

    naiveMethod();

    return 0;
}
```

OUTPUT:



```
Name: Afraaz Hussain
Admission number: 20BDS0374


Enter the size of the text: 14
Enter the text: NOGAMENOLIFENO

Enter the size of the pattern: 2
Enter the pattern: NO

An instance of the pattern was found at index 0
An instance of the pattern was found at index 6
An instance of the pattern was found at index 12

A total of 3 pattern(s) were found!
```

AFRAAZ HUSSAIN
20BDS0374
DESIGN AND ANALYSIS OF ALGORITHMS
LAB ASSESSMENT 3

QUESTION:

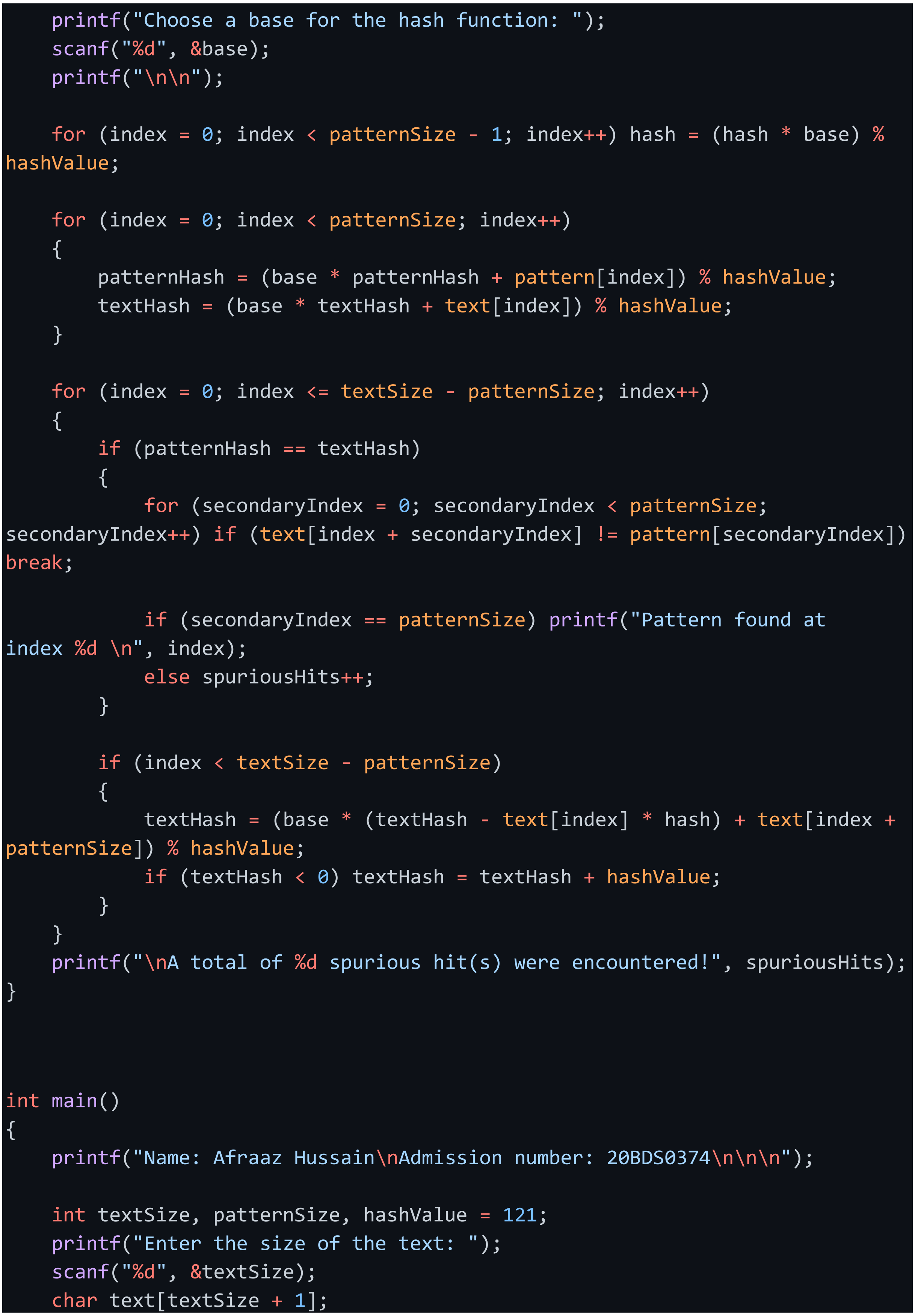
Implement Rabin Karp algorithm to check whether given pattern P is plagiarized in given Text T.

PSEUDOCODE:

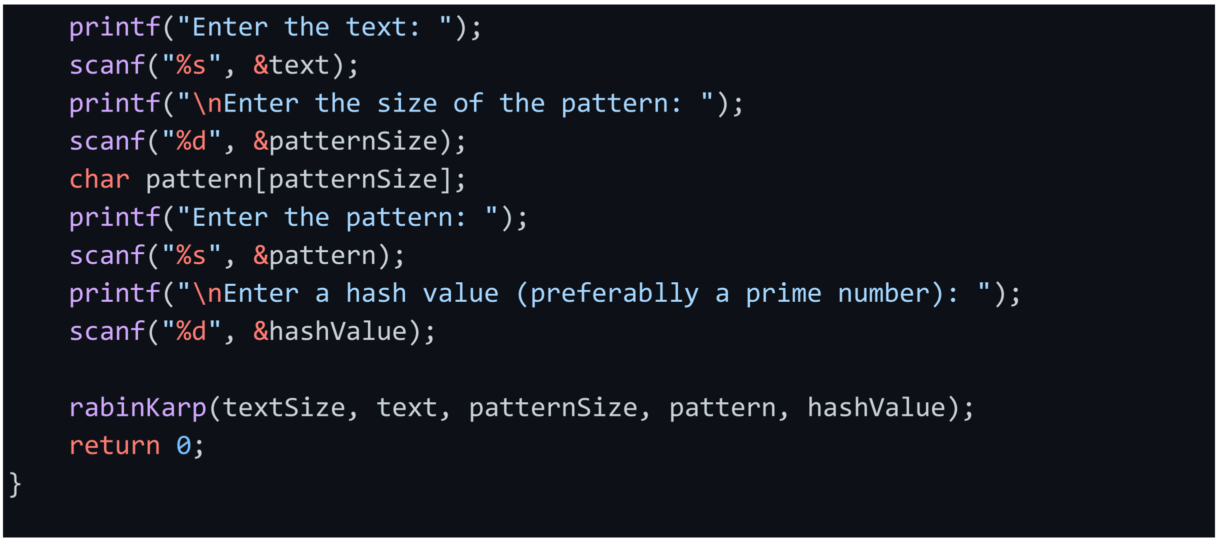
```
function rabinKarp(textSize, text, patternSize, pattern, hashValue):
    base = input()
    int: spuriousHits = 0
    for index from 0 to patternSize:
        hash = (hash * base) % hashValue
    for index from 0 to patternSize:
        patternHash = (base * patternHash + pattern[index]) % hashValue
        textHash = (base * textHash + text[index]) % hashValue
    for index from 0 to textSize + 1:
        if patternHash = textHash:
            for secondaryIndex from 0 to patternSize:
                if text[index + secondaryIndex] != pattern[secondaryIndex]:
                break
            if secondaryIndex = patternSize print("Match found at {index}")
            else add 1 to spuriousHits
        if index < textSize - patternSize:
            textHash = (base * (textHash - text[index] * hash) + text[index +
patternSize]) % hashValue
            if textHash < 0:
                textHash = textHash + hashValue
    print(spuriousHits)

function main():
    textSize, text, patternSize, pattern = input()
    hashValue = input()
    rabinKarp(textSize, text, patternSize, pattern, hashValue)
```

CODE:

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



void rabinKarp(int textSize, char text[], int patternSize, char pattern[], int
hashValue)
{
    int index, secondaryIndex, textHash = 0, patternHash = 0, hash = 1,
spuriousHits = 0, base = 256;

```

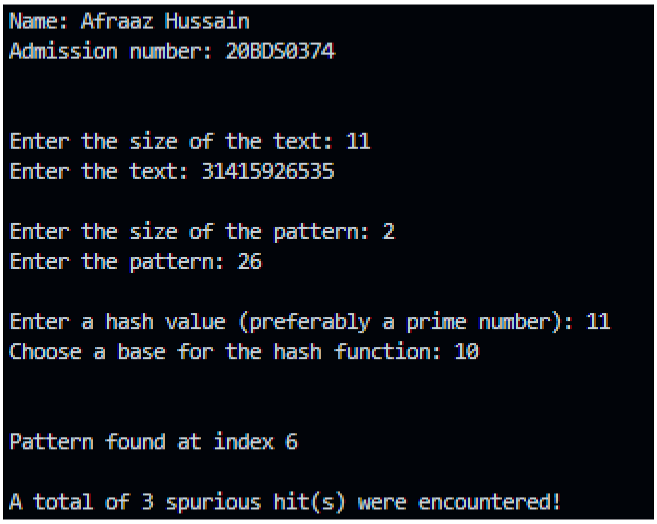


```
    printf("Choose a base for the hash function: ");
    scanf("%d", &base);
    printf("\n\n");

    for (index = 0; index < patternSize - 1; index++) hash = (hash * base) %
hashValue;

    for (index = 0; index < patternSize; index++)
    {
        patternHash = (base * patternHash + pattern[index]) % hashValue;
        textHash = (base * textHash + text[index]) % hashValue;
    }

    for (index = 0; index <= textSize - patternSize; index++)
    {
        if (patternHash == textHash)
        {
            for (secondaryIndex = 0; secondaryIndex < patternSize;
secondaryIndex++) if (text[index + secondaryIndex] != pattern[secondaryIndex])
break;

            if (secondaryIndex == patternSize) printf("Pattern found at
index %d \n", index);
            else spuriousHits++;
        }

        if (index < textSize - patternSize)
        {
            textHash = (base * (textHash - text[index] * hash) + text[index +
patternSize]) % hashValue;
            if (textHash < 0) textHash = textHash + hashValue;
        }
    }
    printf("\nA total of %d spurious hit(s) were encountered!", spuriousHits);
}



int main()
{
    printf("Name: Afraaz Hussain\nAdmission number: 20BDS0374\n\n\n");

    int textSize, patternSize, hashValue = 121;
    printf("Enter the size of the text: ");
    scanf("%d", &textSize);
    char text[textSize + 1];
```



```
    printf("Enter the text: ");
    scanf("%s", &text);
    printf("\nEnter the size of the pattern: ");
    scanf("%d", &patternSize);
    char pattern[patternSize];
    printf("Enter the pattern: ");
    scanf("%s", &pattern);
    printf("\nEnter a hash value (preferablly a prime number): ");
    scanf("%d", &hashValue);

    rabinKarp(textSize, text, patternSize, pattern, hashValue);
    return 0;
}
```

OUTPUT:



```
Name: Afraaz Hussain
Admission number: 20BDS0374


Enter the size of the text: 11
Enter the text: 31415926535

Enter the size of the pattern: 2
Enter the pattern: 26

Enter a hash value (preferably a prime number): 11
Choose a base for the hash function: 10


Pattern found at index 6

A total of 3 spurious hit(s) were encountered!
```