

 <b>Marwadi</b> University	<b>Marwari University</b> <b>Faculty of Technology</b> <b>Department of Information and Communication Technology</b>	
<b>Subject: Design and Analysis of Algorithms (01CT0512)</b>	<b>Aim: C++ ESE Practical Exam Submission</b>	
<b>Final Practical</b>	<b>Date: 19-12-2024</b>	<b>Enrollment No: 92200133030</b>

**Aim:** C++ ESE Practical Exam Submission

**IDE:** Visual Studio Code

**Programming Language:** C++

### **Question-1(A)**

**Code :-**

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

const int PRIME = 101;
const int MOD = 1e9 + 7;

long long calculateHash(const string &str, int len)
{
    long long hash = 0;
    long long power = 1; // PRIME^0
    for (int i = 0; i < len; ++i)
    {
        hash = (hash + str[i] * power) % MOD;
        power = (power * PRIME) % MOD;
    }
    return hash;
}

long long recalculateHash(const string &text, int oldIndex, int newIndex, long long oldHash, int patternLen, long long primePower)
{
    oldHash = (oldHash - text[oldIndex] + MOD) % MOD;
    oldHash = (oldHash / PRIME) % MOD;
    oldHash = (oldHash + text[newIndex] * primePower) % MOD;
    return oldHash;
}

vector<int> Rabin_Karp(const string &text, const string &pattern)
{
    vector<int> result;
    int textLen = text.size();
    int patternLen = pattern.size();
    // ... (rest of the code) ...
}
```

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```

if (patternLen > textLen)
{
    return result;
}

long long patternHash = calculateHash(pattern, patternLen);
long long textHash = calculateHash(text, patternLen);

long long primePower = 1;
for (int i = 1; i < patternLen; ++i)
{
    primePower = (primePower * PRIME) % MOD;
}

for (int i = 0; i <= textLen - patternLen; ++i)
{
    if (textHash == patternHash && text.substr(i, patternLen) == pattern)
    {
        result.push_back(i);
    }

    if (i < textLen - patternLen)
    {
        textHash = recalculateHash(text, i, i + patternLen, textHash, patternLen, primePower);
    }
}

return result;
}

int main()
{
    string Reference_string = "ATGC";
    string Input_String = "";
    string pattern = "AGC";
    srand(time(0));

    for (int i = 0; i < 25; i++)
    {
        Input_String += Reference_string[rand() % 4];
    }

```

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```

cout << "Random String: " << Input_String << endl;
cout << "Pattern: " << pattern << endl;

vector<int> occurrences = Rabin_Karp(Input_String, pattern);

if (occurrences.size() == 0)
{
    cout << "No occurrences found for the pattern." << endl;
}

else
{
    cout << "Number of occurrences: " << occurrences.size() << endl;

    cout << "Occurrences Founded At Indices :- ";

    for (int ocr : occurrences)
    {
        cout << ocr << " ";
    }

    cout << endl;
}

return 0;
}

```

**Output :-**

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```
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Random String: GTTATCATTGTAGTAGGCAATGCGA
Pattern: AGC
No occurrences found for the pattern.
PS D:\Aryan Data\Usefull Data\Semester - 5\Design-and-Analysis-of-Algorithms\Final Practical Exam 19-12-2024> cd "d:\Aryan Data\Usefull Data\Semester - 5\Design-and-Analysis-of-Algorithms\Final Practical Exam 19-12-2024\" ; if ($?) { g++ Question_1_A.cpp -o Question_1_A } ; if ($?) { .\Question_1_A }
Pattern: AGC
No occurrences found for the pattern.
PS D:\Aryan Data\Usefull Data\Semester - 5\Design-and-Analysis-of-Algorithms\Final Practical Exam 19-12-2024> cd "d:\Aryan Data\Usefull Data\Semester - 5\Design-and-Analysis-of-Algorithms\Final Practical Exam 19-12-2024\" ; if ($?) { g++ Question_1_A.cpp -o Question_1_A } ; if ($?) { .\Question_1_A }
Random String: CCGTGTGACTGATTTAGGACCTCC
Pattern: AGC
PS D:\Aryan Data\Usefull Data\Semester - 5\Design-and-Analysis-of-Algorithms\Final Practical Exam 19-12-2024> cd "d:\Aryan Data\Usefull Data\Semester - 5\Design-and-Analysis-of-Algorithms\Final Practical Exam 19-12-2024\" ; if ($?) { g++ Question_1_A.cpp -o Question_1_A } ; if ($?) { .\Question_1_A }
Random String: CCGTGTGACTGATTTAGGACCTCC
Pattern: AGC
No occurrences found for the pattern.
PS D:\Aryan Data\Usefull Data\Semester - 5\Design-and-Analysis-of-Algorithms\Final Practical Exam 19-12-2024> cd "d:\Aryan Data\Usefull Data\Semester - 5\Design-and-Analysis-of-Algorithms\Final Practical Exam 19-12-2024\" ; if ($?) { g++ Question_1_A.cpp -o Question_1_A } ; if ($?) { .\Question_1_A }
No occurrences found for the pattern.
PS D:\Aryan Data\Usefull Data\Semester - 5\Design-and-Analysis-of-Algorithms\Final Practical Exam 19-12-2024> cd "d:\Aryan Data\Usefull Data\Semester - 5\Design-and-Analysis-of-Algorithms\Final Practical Exam 19-12-2024\" ; if ($?) { g++ Question_1_A.cpp -o Question_1_A } ; if ($?) { .\Question_1_A }
Random String: ACTCTACCCAATGCACCGATTGTGC
Algorithms\Final Practical Exam 19-12-2024\" ; if ($?) { g++ Question_1_A.cpp -o Question_1_A } ; if ($?) { .\Question_1_A }
Random String: ACTCTACCCAATGCACCGATTGTGC
Random String: ACTCTACCCAATGCACCGATTGTGC
Pattern: AGC
No occurrences found for the pattern.
PS D:\Aryan Data\Usefull Data\Semester - 5\Design-and-Analysis-of-Algorithms\Final Practical Exam 19-12-2024> cd "d:\Aryan Data\Usefull Data\Semester - 5\Design-and-Analysis-of-Algorithms\Final Practical Exam 19-12-2024\" ; if ($?) { g++ Question_1_A.cpp -o Question_1_A } ; if ($?) { .\Question_1_A }
Random String: TTGACCTGTAATGTTCCCACTTGG
Pattern: AGC
No occurrences found for the pattern.
PS D:\Aryan Data\Usefull Data\Semester - 5\Design-and-Analysis-of-Algorithms\Final Practical Exam 19-12-2024> cd "d:\Aryan Data\Usefull Data\Semester - 5\Design-and-Analysis-of-Algorithms\Final Practical Exam 19-12-2024\" ; if ($?) { g++ Question_1_A.cpp -o Question_1_A } ; if ($?) { .\Question_1_A }
Random String: ATCGAGCATGCAGCATCGAGCATCGAGCATCG
Pattern: AGC
Number of occurrences: 4
Occurrences Found At Indices :- 4 11 18 25
PS D:\Aryan Data\Usefull Data\Semester - 5\Design-and-Analysis-of-Algorithms\Final Practical Exam 19-12-2024> 
```

## Question – 1(B)

### Code :-

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

vector<string> Split_String(string &submitted_doc)
{
    vector<string> input_string;

    string s = "";
```

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```

for (char c : submitted_doc)
{

    if (c == ',' || c == '.')
    {
        continue;
    }

    if (c == ' ')
    {
        input_string.push_back(s);
        s = "";
    }

    else
    {
        s = s + c;
    }
}

return input_string;
}

int main()
{
    string submitted_doc = "In this Paper, We propose a new algorithm for sorting.";
    string reference_doc = "This paper introduces a new sorting algorithm";

    vector<string> input_string = Split_String(submitted_doc);
    vector<string> reference_string = Split_String(reference_doc);

    int n = input_string.size();
    int m = reference_string.size();

    int lcs[n + 1][m + 1];

    for (int i = 0; i <= n; i++)
    {
        for (int j = 0; j <= m; j++)
        {
            if (i == 0 || j == 0)
                lcs[i][j] = 0;
            else if (input_string[i - 1] == reference_string[j - 1])
                lcs[i][j] = lcs[i - 1][j - 1] + 1;

```

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```

else
    lcs[i][j] = max(lcs[i - 1][j], lcs[i][j - 1]);
}
}

bool found = lcs[n + 1][m + 1] >= 4;

cout << "Found: " << (found ? "Yes" : "No") << endl;

return 0;
}

```

### Output :-

```

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Found: Yes
PS D:\Aryan Data\Usefull Data\Semester - 5\Design-and-Analysis-of-Algorithms\Final Practical Exam 19-12-2024> 

```

### Question – 2(A)

#### Code :-

```

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

int main()
{
    int denomination;
    cout << "Enter the Number of Denominations :- ";
    cin >> denomination;

    vector<pair<int, int>> storage;

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

        cout << "Enter The Details for (" << i + 1 << ") Coins :-" << endl;

        int val = 0;
        int quantity = 0;

        cout << "Enter the Value of Coin :- ";
        cin >> val;
    }
}

```

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```

    cout << "Enter the Quantity of Coins :- ";
    cin >> quantity;

    storage.push_back({val, quantity});
}

sort(storage.begin(), storage.end(), [](const pair<int, int> &a, const pair<int, int> &b)
      { return a.first > b.first; });

int amount;
cout << "Enter the Amount :- ";
cin >> amount;

vector<int> dp(amount + 1, INT_MAX);
dp[0] = 0;

for (int i = 0; i < denomination; i++)
{
    for (int j = storage[i].first; j <= amount; j++)
    {
        if (dp[j - storage[i].first] != INT_MAX && dp[j - storage[i].first] + 1 < dp[j])
        {
            dp[j] = dp[j - storage[i].first] + 1;
        }
    }
}

if (dp[amount] == INT_MAX)
{
    cout << "Minimum Number of Coins Required is Not Possible" << endl;
}
else
{
    cout << "Minimum Number of Coins Required is " << dp[amount] << endl;
}
return 0;
}

```

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### Output :-

```
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Enter the Number of Denominations :- 5
Enter The Details for (1) Coins :-
Enter the Value of Coin :- 1
Enter the Quantity of Coins :- 12
Enter The Details for (2) Coins :-
Enter the Value of Coin :- 2
Enter the Quantity of Coins :- 14
Enter The Details for (3) Coins :-
Enter the Value of Coin :- 5
Enter the Quantity of Coins :- 7
Enter The Details for (4) Coins :-
Enter the Value of coin :- 10
Enter the Quantity of Coins :- 21
Enter The Details for (5) Coins :-
Enter the Value of coin :- 20
Enter the Quantity of Coins :- 2
Enter the Amount :- 210
Minimum Number of Coins Required is 11
PS D:\Aryan Data\Usefull Data\Semester - 5\Design-and-Analysis-of-Algorithms\Final Practical Exam 19-12-2024> |
```

### Question – 2(B)

#### Code :-

```
#include <iostream>
#include <vector>
#include <algorithm>

using namespace std;

int maxSegments(int n, int x, int y, int z)
{
    vector<int> dp(n + 1, -1);
    dp[0] = 0;

    for (int i = 1; i <= n; ++i)
    {
        if (i >= x && dp[i - x] != -1)
        {
            dp[i] = max(dp[i], dp[i - x] + 1);
        }
        if (i >= y && dp[i - y] != -1)
        {
            dp[i] = max(dp[i], dp[i - y] + 1);
        }
    }
}
```



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```

        if (i >= z && dp[i - z] != -1)
        {
            dp[i] = max(dp[i], dp[i - z] + 1);
        }
    }

    return dp[n] != -1 ? dp[n] : 0;
}

int main()
{
    int n, x, y, z;

    cout << "Enter the length of the line segment (n): ";
    cin >> n;
    cout << "Enter the first cut length (x): ";
    cin >> x;
    cout << "Enter the second cut length (y): ";
    cin >> y;
    cout << "Enter the third cut length (z): ";
    cin >> z;

    int result = maxSegments(n, x, y, z);
    cout << "The maximum number of segments that can be cut from length " << n
        << " using lengths " << x << ", " << y << ", and " << z << " is: " << result << endl;

    return 0;
}

```

### Output :-

```

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Enter the length of the line segment (n): 5
Enter the first cut length (x): 5
Enter the second cut length (y): 3
Enter the third cut length (z): 2
The maximum number of segments that can be cut from length 5 using lengths 5, 3, and 2 is: 2
PS D:\Aryan Data\Usefull Data\Semester - 5\Design-and-Analysis-of-Algorithms\Final Practical Exam 19-12-2024>

```

### Question – 3(A)

### Code :-

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

```
void findCriticalConnections(vector<vector<int>> &graph, int node)
{
    int min_degree = INT_MAX;
    int src = -1;
    int dest = -1;
    vector<pair<int, int>> criticalConnections;

    for (int i = 0; i < node; i++)
    {
        int curr_degree = 0;

        for (int j = 0; j < node; j++)
        {
            if (graph[i][j] != 9999 && graph[i][j] != 0)
                curr_degree++;
        }

        if (curr_degree == 1)
        {
            for (int j = 0; j < node; j++)
            {
                if (graph[i][j] != 9999 && graph[i][j] != 0)
                {
                    src = i;
                    dest = j;
                    criticalConnections.push_back({src, dest});
                }
            }
        }
    }

    for (auto connection : criticalConnections)
    {
        cout << "The Critical Connection is from " << connection.first << " to " << connection.second
<< endl;
    }
}

int main()
{
```

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```

int node;

cout << "Enter The Number of Nodes :- ";
cin >> node;

vector<vector<int>> graph(node, vector<int>(node, 9999));

cout << "Enter The Adjacency Matrix :- " << endl;

for (int i = 0; i < node; i++)
{
    for (int j = 0; j < node; j++)
    {
        cout << "Enter The Edge from " << i << " to " << j << " (9999 for no edge) :- ";
        cin >> graph[i][j];
    }
}

findCriticalConnections(graph, node);

return 0;
}

```

### Output :-

```

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Enter The Number of Nodes :- 3
Enter The Adjacency Matrix :-
Enter The Edge from 0 to 0 (9999 for no edge) :- 0
Enter The Edge from 0 to 1 (9999 for no edge) :- 12
Enter The Edge from 0 to 2 (9999 for no edge) :- 15
Enter The Edge from 1 to 0 (9999 for no edge) :- 9999
Enter The Edge from 1 to 1 (9999 for no edge) :- 0
Enter The Edge from 1 to 2 (9999 for no edge) :- 16
Enter The Edge from 2 to 0 (9999 for no edge) :- 45
Enter The Edge from 2 to 1 (9999 for no edge) :- 56
Enter The Edge from 2 to 2 (9999 for no edge) :- 0
The Critical Connection is from 1 to 2
PS D:\Aryan Data\Usefull Data\Semester - 5\Design-and-Analysis-of-Algorithms\Final Practical Exam 19-12-2024> 

```

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### Question – 3(B)

#### Code :-

```
#include <bits/stdc++.h>
using namespace std;
#define V 5
#define INF 99999

void printSolution(int dist[][V])
{
    cout << "The following matrix shows the shortest "
           "distances"
           " between every pair of vertices \n";
    for (int i = 0; i < V; i++)
    {
        for (int j = 0; j < V; j++)
        {
            if (dist[i][j] == INF)
                cout << "INF"
                    << " ";
            else
                cout << dist[i][j] << " ";
        }
        cout << endl;
    }
}

void floydWarshall(int dist[][V])
```

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```
{

    int i, j, k;

    for (k = 0; k < V; k++)
    {
        for (i = 0; i < V; i++)
        {
            for (j = 0; j < V; j++)
            {

                if (dist[i][j] > (dist[i][k] + dist[k][j]) && (dist[k][j] != INF && dist[i][k] !=
INF))

                    dist[i][j] = dist[i][k] + dist[k][j];

            }
        }
    }

    printSolution(dist);
}

int main()
{
    int graph[V][V] = {{0, 3, INF, 7, 8},
                        {INF, 0, 1, 4, INF},
                        {INF, INF, 0, INF, INF},
                        {INF, INF, 2, 0, INF},
                        {INF, INF, INF, 3, 0}};

    floydWarshall(graph);
    return 0;
}
```

**Output :-**

```
PS D:\Aryan Data\Usefull Data\Semester - 5\Design-and-Analysis-of-Algorithms\Final Practical Exam 19-12-2024> cd "d:\Aryan Data\Usefull Data\Semester - 5\Design-and-Analysis-of-Algorithms\Final Practical Exam 19-12-2024\" ; if ($?) { g++ Question_3_B.cpp -o Question_3_B } ; if ($?) { .\Question_3_B }
The following matrix shows the shortest distances between every pair of vertices
0  3  4  7  8
INF 0  1  4  INF
INF INF 0  INF INF
INF INF 2  0  INF
INF INF 5  3  0
PS D:\Aryan Data\Usefull Data\Semester - 5\Design-and-Analysis-of-Algorithms\Final Practical Exam 19-12-2024> |
```

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## Question - 4

### Code :-

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

void Prime_Factorization(long long n)
{
    for (long long i = 2; i * i <= n; i++)
    {
        while (n % i == 0)
        {
            cout << i << " X ";
            n /= i;
        }
    }
    if (n > 1)
    {
        cout << n;
    }
}

int main()
{
    long long number;

    cout << "Enter A Number :- ";
    cin >> number;
```

 <b>Marwadi</b> University	<b>Marwari University</b> <b>Faculty of Technology</b> <b>Department of Information and Communication Technology</b>	
<b>Subject: Design and Analysis of Algorithms (01CT0512)</b>	<b>Aim: C++ ESE Practical Exam Submission</b>	
<b>Final Practical</b>	<b>Date: 19-12-2024</b>	<b>Enrollment No: 92200133030</b>

```

    cout << "Prime Factorization of " << number << " is : ";
    Prime_Factorization(number);

    return 0;
}

```

### Output :-

```

PS D:\Aryan Data\Usefull Data\Semester - 5\Design-and-Analysis-of-Algorithms\Final Practical Exam 19-12-2024> cd "d:\Aryan Data\Usefull Data\Semester - 5\Design-and-Analysis-of-Algorithms\Final Practical Exam 19-12-2024\" ; if ($?) { g++ Question_4.cpp -o Question_4 } ; if ($?) { .\Question_4 }
Enter A Number :- 264
Prime Factorization of 264 is : 2 X 2 X 2 X 3 X 11
PS D:\Aryan Data\Usefull Data\Semester - 5\Design-and-Analysis-of-Algorithms\Final Practical Exam 19-12-2024>

```