AHSANIA MISSION UNIVERSITY OF SCIENCE & TECHNOLOGY

Lab Report-6

Lab No: 06

Course Code: CSE 2202

Course Title: Computer Algorithm Sessional.

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Task No.: 01

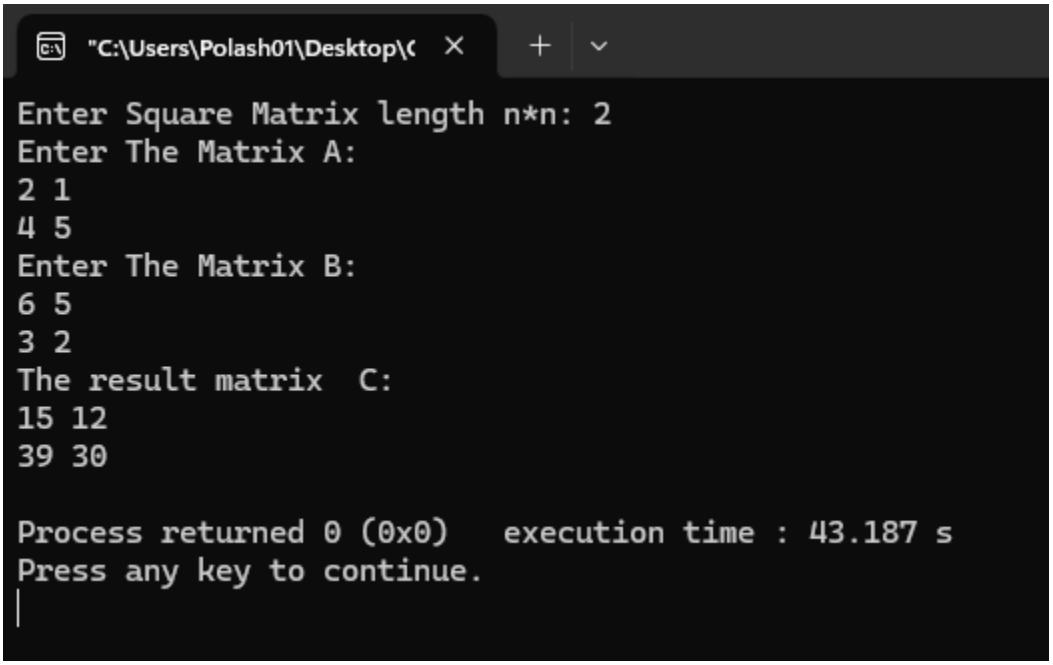
Problem Statement: Matrix Multiplication Using Naive Approach.

Source Code:

```
#include<iostream>
using namespace std;
int main()
{
   int n;
   cout<<"Enter Square Matrix length n*n: ";
   cin>>n;
   int A[n][n],B[n][n],C[n][n];
   int i=0, j=0, k=0;
   cout<<"Enter The Matrix A:"<<endl;
   for(i=0;i<n;i++)
   {
      for(j=0;j<n;j++)
      {
         cin>>A[i][j];
      }
   }
   cout<<"Enter The Matrix B:"<<endl;
   for(i=0;i<n;i++)
   {
      for(j=0;j<n;j++)
      {
         cin>>B[i][j];
      }
   }
   for(i=0;i<n;i++)
   {
      for(j=0;j<n;j++)
      {
         C[i][j]=0;
         for(k=0;k<n;k++)
         {
            C[i][j]+=A[i][k]*B[k][j];
         }
      }
   }
   cout<<"The result matrix  C:"<<endl;
   for(i=0;i<n;i++)
   {
      for(j=0;j<n;j++)
      {
```

```
            cout<<C[i][j]<<" ";
        }
        cout<<endl;
    }
}
```

Output:



Task No.: 02

Problem Statement: Matrix Multiplication Using Divide and Conquer Approach.

Source Code:

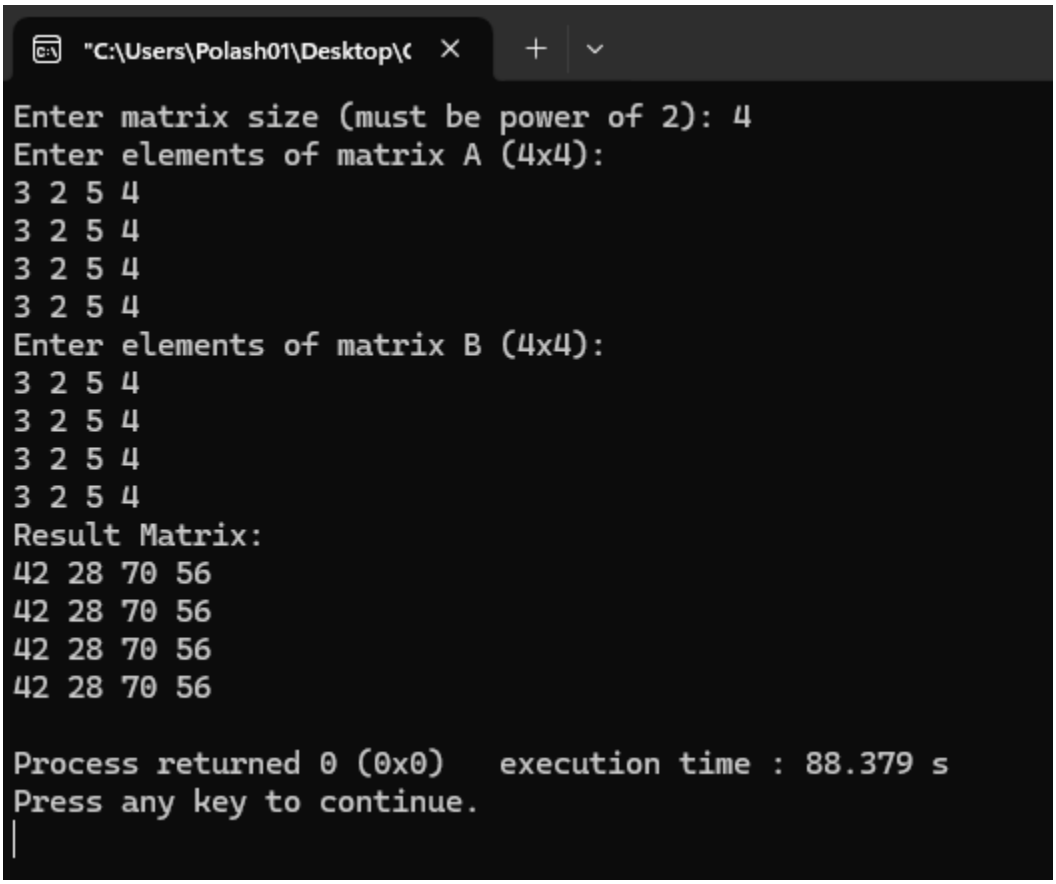
```
#include <iostream>
#include <vector>
using namespace std;

typedef vector<vector<int>> Matrix;

// Matrix addition
Matrix add(const Matrix &A, const Matrix &B) {
    int n = A.size();
    Matrix C(n, vector<int>(n));
    for (int i = 0; i < n; i++)
        for (int j = 0; j < n; j++)
```

```
            C[i][j] = A[i][j] + B[i][j];
    return C;
}

// Matrix subtraction
Matrix subtract(const Matrix &A, const Matrix &B) {
    int n = A.size();
    Matrix C(n, vector<int>(n));
    for (int i = 0; i < n; i++)
        for (int j = 0; j < n; j++)
            C[i][j] = A[i][j] - B[i][j];
    return C;
}

// Recursive matrix multiplication (divide and conquer)
Matrix multiply(const Matrix &A, const Matrix &B) {
    int n = A.size();
    Matrix C(n, vector<int>(n, 0));
    if (n == 1) {
        C[0][0] = A[0][0] * B[0][0];
    } else {
        int k = n / 2;
        Matrix A11(k, vector<int>(k)), A12(k, vector<int>(k)), A21(k, vector<int>(k)), A22(k, vector<int>(k));
        Matrix B11(k, vector<int>(k)), B12(k, vector<int>(k)), B21(k, vector<int>(k)), B22(k, vector<int>(k));

        for (int i = 0; i < k; i++)
            for (int j = 0; j < k; j++) {
                A11[i][j] = A[i][j];
                A12[i][j] = A[i][j + k];
                A21[i][j] = A[i + k][j];
                A22[i][j] = A[i + k][j + k];
                B11[i][j] = B[i][j];
                B12[i][j] = B[i][j + k];
                B21[i][j] = B[i + k][j];
                B22[i][j] = B[i + k][j + k];
            }

        Matrix C11 = add(multiply(A11, B11), multiply(A12, B21));
        Matrix C12 = add(multiply(A11, B12), multiply(A12, B22));
        Matrix C21 = add(multiply(A21, B11), multiply(A22, B21));
        Matrix C22 = add(multiply(A21, B12), multiply(A22, B22));

        for (int i = 0; i < k; i++)
            for (int j = 0; j < k; j++) {
                C[i][j] = C11[i][j];
                C[i][j + k] = C12[i][j];
```

```
            C[i + k][j] = C21[i][j];
            C[i + k][j + k] = C22[i][j];
        }
    }
    return C;
}

// Input a square matrix
Matrix inputMatrix(int size, char name) {
    Matrix mat(size, vector<int>(size));
    cout << "Enter elements of matrix " << name << " (" << size << "x" << size << "):\n";
    for (int i = 0; i < size; ++i)
        for (int j = 0; j < size; ++j)
            cin >> mat[i][j];
    return mat;
}

// Print a matrix
void printMatrix(const Matrix &mat) {
    int size = mat.size();
    for (int i = 0; i < size; ++i) {
        for (int j = 0; j < size; ++j) {
            cout << mat[i][j] << " ";
        }
        cout << endl;
    }
}

// Main function
int main() {
    int n;
    cout << "Enter matrix size (must be power of 2): ";
    cin >> n;

    if ((n & (n - 1)) != 0 || n <= 0) {
        cout << "Size must be a positive power of 2." << endl;
        return 1;
    }

    Matrix A = inputMatrix(n, 'A');
    Matrix B = inputMatrix(n, 'B');

    Matrix C = multiply(A, B);

    cout << "Result Matrix:" << endl;
    printMatrix(C);
```

```
    return 0;
}
```

Output:



Task No.: 03

Problem Statement: Matrix Multiplication Using Strassen's Algorithm

Source Code:

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

using namespace std;

typedef vector<vector<int>> Matrix;

Matrix add(const Matrix &A, const Matrix &B)
{
    int n = A.size();
    Matrix result(n, vector<int>(n, 0));
    for (int i = 0; i < n; ++i)
```

```
      for (int j = 0; j < n; ++j)
         result[i][j] = A[i][j] + B[i][j];
   return result;
}

Matrix subtract(const Matrix &A, const Matrix &B)
{
   int n = A.size();
   Matrix result(n, vector<int>(n, 0));
   for (int i = 0; i < n; ++i)
      for (int j = 0; j < n; ++j)
         result[i][j] = A[i][j] - B[i][j];
   return result;
}

void split(const Matrix &A, Matrix &A11, Matrix &A12, Matrix &A21, Matrix &A22)
{
   int n = A.size() / 2;
   for (int i = 0; i < n; ++i)
   {
      for (int j = 0; j < n; ++j)
      {
         A11[i][j] = A[i][j];
         A12[i][j] = A[i][j + n];
         A21[i][j] = A[i + n][j];
         A22[i][j] = A[i + n][j + n];
      }
   }
}

Matrix combine(const Matrix &C11, const Matrix &C12, const Matrix &C21, const Matrix &C22)
{
   int n = C11.size();
   Matrix C(2 * n, vector<int>(2 * n));
   for (int i = 0; i < n; ++i)
   {
      for (int j = 0; j < n; ++j)
      {
         C[i][j] = C11[i][j];
         C[i][j + n] = C12[i][j];
         C[i + n][j] = C21[i][j];
         C[i + n][j + n] = C22[i][j];
      }
   }
   return C;
}
```

```
Matrix strassen(const Matrix &A, const Matrix &B)
{
    int n = A.size();
    if (n == 1)
    {
        return Matrix{{A[0][0] * B[0][0]}};
    }

    int newSize = n / 2;
    Matrix A11(newSize, vector<int>(newSize));
    Matrix A12(newSize, vector<int>(newSize));
    Matrix A21(newSize, vector<int>(newSize));
    Matrix A22(newSize, vector<int>(newSize));
    Matrix B11(newSize, vector<int>(newSize));
    Matrix B12(newSize, vector<int>(newSize));
    Matrix B21(newSize, vector<int>(newSize));
    Matrix B22(newSize, vector<int>(newSize));

    split(A, A11, A12, A21, A22);
    split(B, B11, B12, B21, B22);

    Matrix P1 = strassen(A11, subtract(B12, B22));
    Matrix P2 = strassen(add(A11, A12), B22);
    Matrix P3 = strassen(add(A21, A22), B11);
    Matrix P4 = strassen(A22, subtract(B21, B11));
    Matrix P5 = strassen(add(A11, A22), add(B11, B22));
    Matrix P6 = strassen(subtract(A12, A22), add(B21, B22));
    Matrix P7 = strassen(subtract(A11, A21), add(B11, B12));

    Matrix C11 = add(subtract(add(P5, P4), P2), P6);
    Matrix C12 = add(P1, P2);
    Matrix C21 = add(P3, P4);
    Matrix C22 = subtract(subtract(add(P1, P5), P3), P7);

    return combine(C11, C12, C21, C22);
}

void printMatrix(const Matrix &matrix)
{
    for (const auto &row : matrix)
    {
        for (int val : row)
            cout << val << " ";
        cout << endl;
    }
```

```
}

Matrix inputMatrix(int size, char name)
{
   Matrix mat(size, vector<int>(size));
   cout << "Enter elements of matrix " << name << " (" << size << "x" << size << "):\n";
   for (int i = 0; i < size; ++i)
      for (int j = 0; j < size; ++j)
      {
         //cout << name << "[" << i << "][" << j << "]: ";
         cin >> mat[i][j];
      }
   return mat;
}

int main()
{
   int n;
   cout << "Enter matrix size (must be power of 2): ";
   cin >> n;

   if ((n & (n - 1)) != 0 || n <= 0)
   {
      cout << "Size must be a positive power of 2." << endl;
      return 1;
   }

   Matrix A = inputMatrix(n, 'A');
   Matrix B = inputMatrix(n, 'B');

   Matrix C = strassen(A, B);

   cout << "Result Matrix:" << endl;
   printMatrix(C);

   return 0;
}
```

Output: