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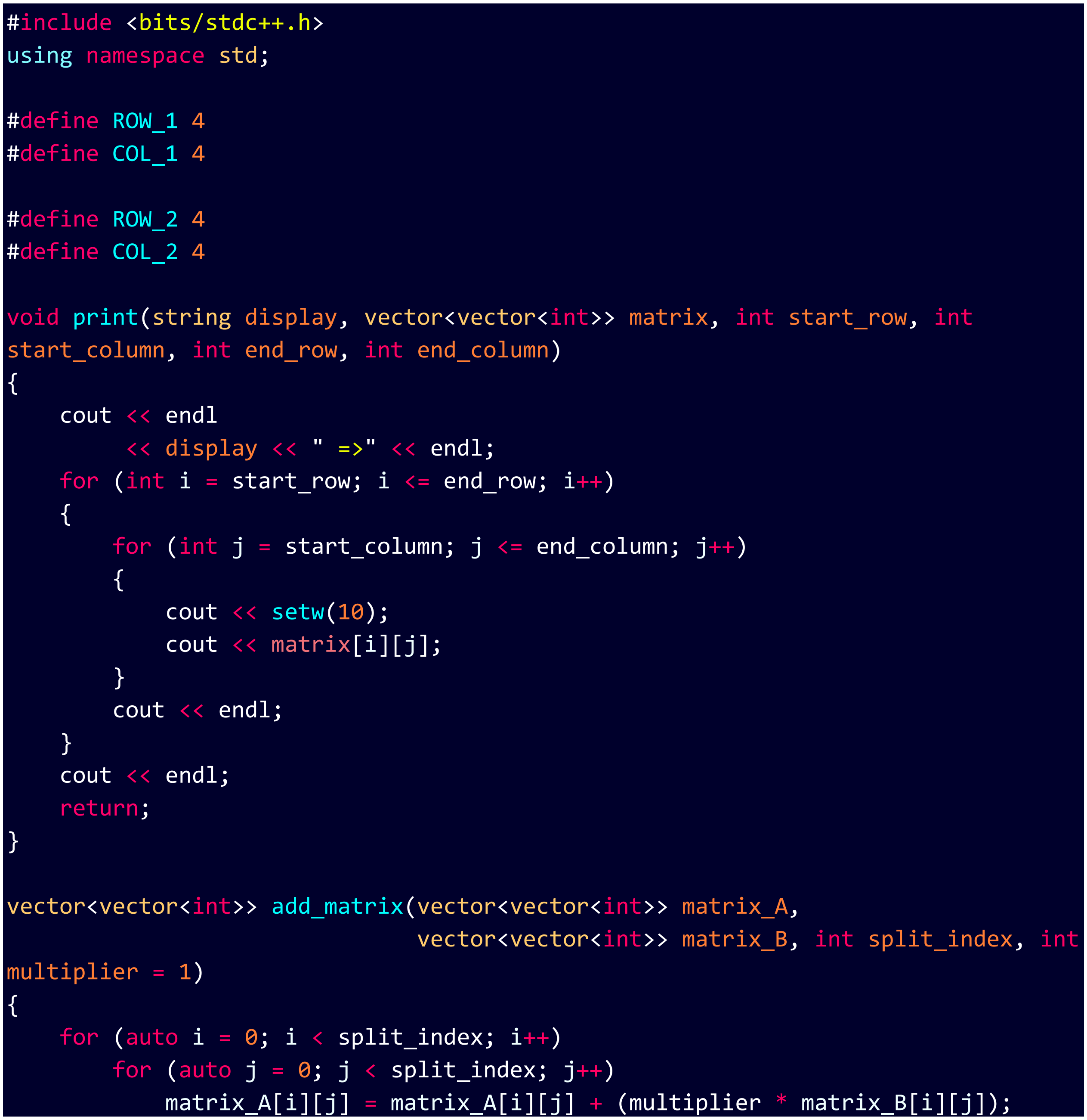
PRN:2020BTECS00090

Ass no:4

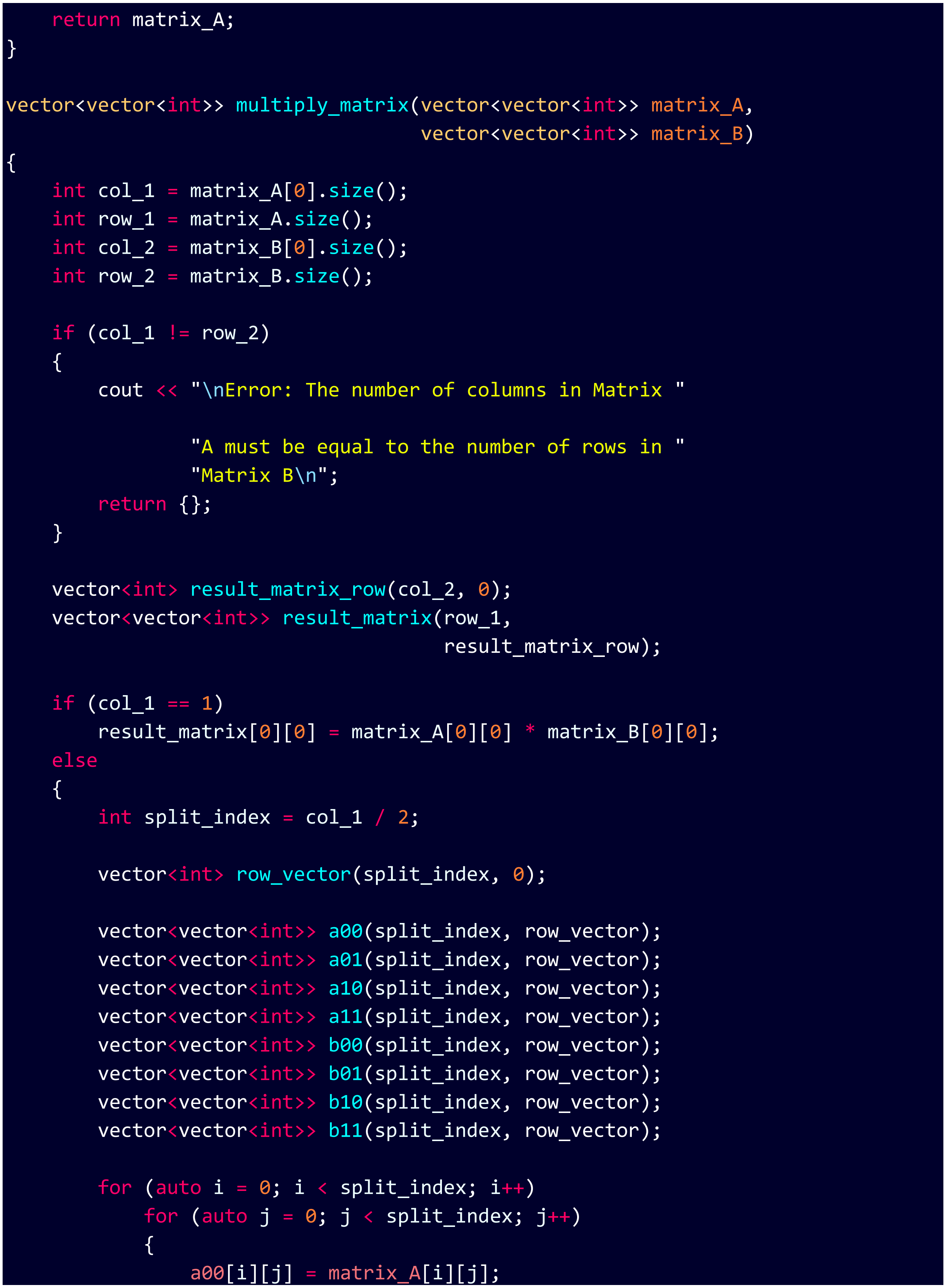
Course: Design and analysis of algorithm Lab

Batch:T6 Class:TYCSE,WCE

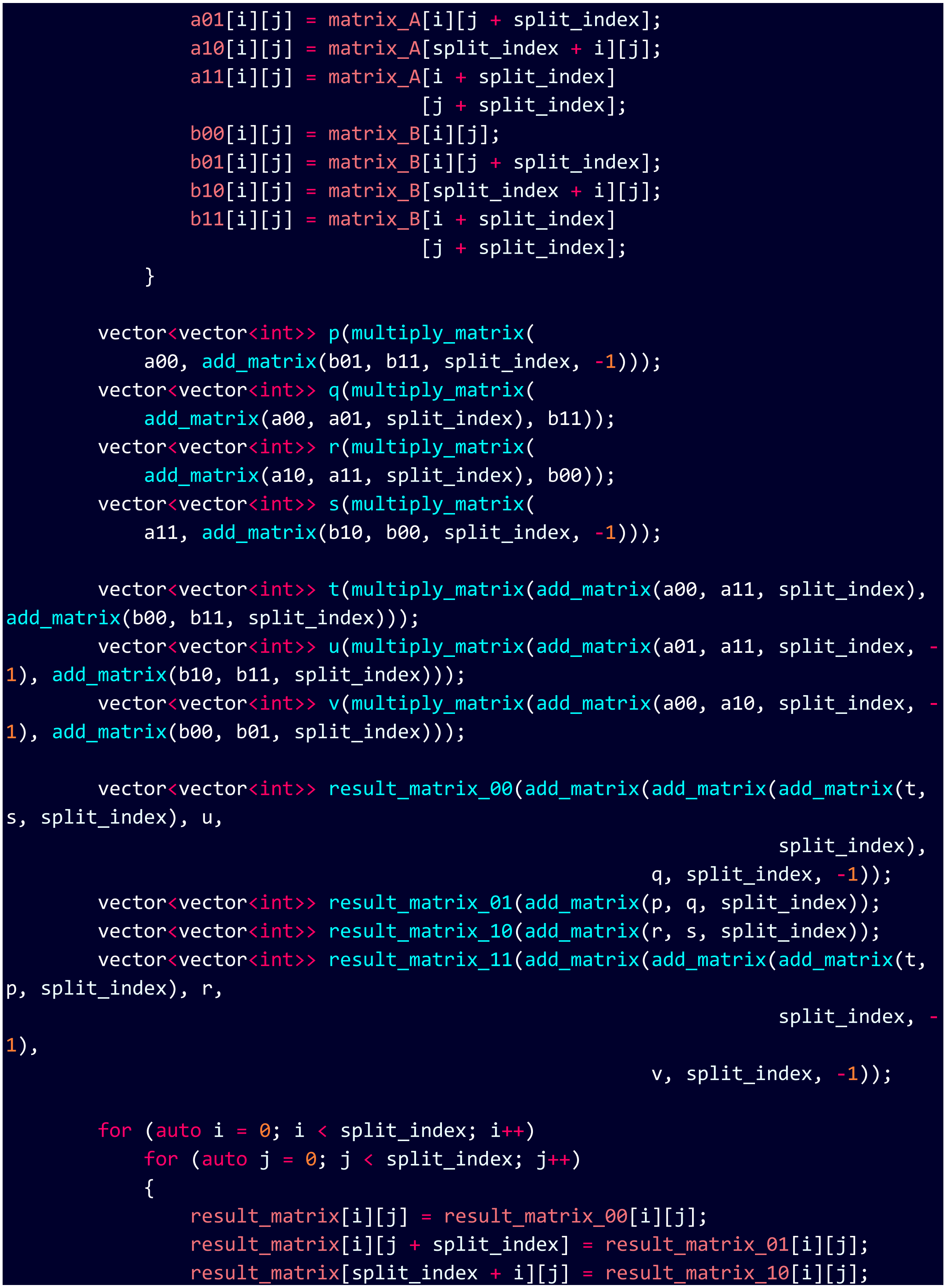
ANS:



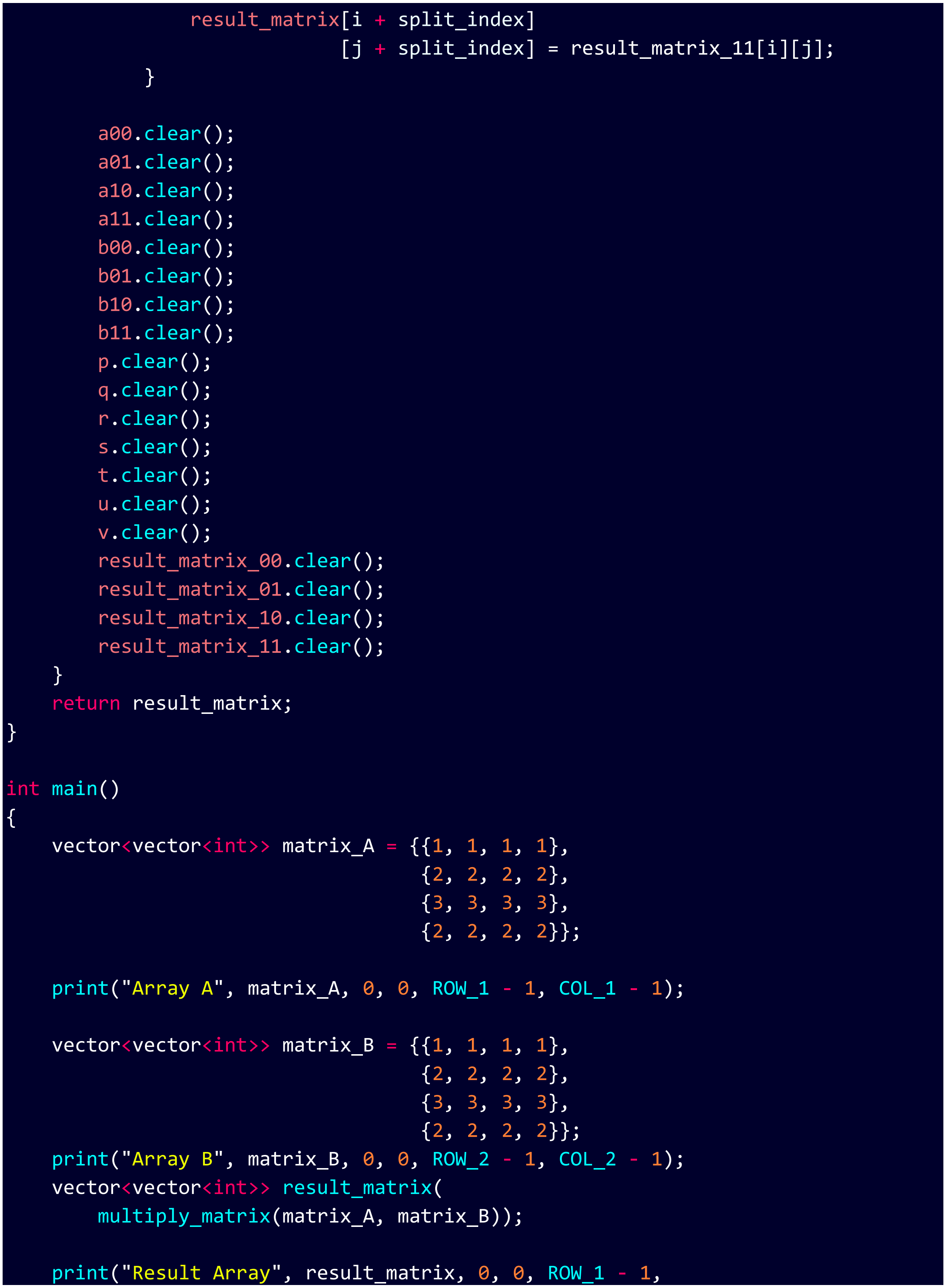
```
#include <bits/stdc++.h>
using namespace std;

#define ROW_1 4
#define COL_1 4

#define ROW_2 4
#define COL_2 4

void print(string display, vector<vector<int>> matrix, int start_row, int
start_column, int end_row, int end_column)
{
    cout << endl
         << display << " =>" << endl;
    for (int i = start_row; i <= end_row; i++)
    {
        for (int j = start_column; j <= end_column; j++)
        {
            cout << setw(10);
            cout << matrix[i][j];
        }
        cout << endl;
    }
    cout << endl;
    return;
}

vector<vector<int>> add_matrix(vector<vector<int>> matrix_A,
                               vector<vector<int>> matrix_B, int split_index, int
multiplier = 1)
{
    for (auto i = 0; i < split_index; i++)
        for (auto j = 0; j < split_index; j++)
            matrix_A[i][j] = matrix_A[i][j] + (multiplier * matrix_B[i][j]);
```



```
    return matrix_A;
}

vector<vector<int>> multiply_matrix(vector<vector<int>> matrix_A,
                                    vector<vector<int>> matrix_B)
{
    int col_1 = matrix_A[0].size();
    int row_1 = matrix_A.size();
    int col_2 = matrix_B[0].size();
    int row_2 = matrix_B.size();

    if (col_1 != row_2)
    {
        cout << "\nError: The number of columns in Matrix "

                "A must be equal to the number of rows in "
                "Matrix B\n";
        return {};
    }

    vector<int> result_matrix_row(col_2, 0);
    vector<vector<int>> result_matrix(row_1,
                                      result_matrix_row);

    if (col_1 == 1)
        result_matrix[0][0] = matrix_A[0][0] * matrix_B[0][0];
    else
    {
        int split_index = col_1 / 2;

        vector<int> row_vector(split_index, 0);

        vector<vector<int>> a00(split_index, row_vector);
        vector<vector<int>> a01(split_index, row_vector);
        vector<vector<int>> a10(split_index, row_vector);
        vector<vector<int>> a11(split_index, row_vector);
        vector<vector<int>> b00(split_index, row_vector);
        vector<vector<int>> b01(split_index, row_vector);
        vector<vector<int>> b10(split_index, row_vector);
        vector<vector<int>> b11(split_index, row_vector);

        for (auto i = 0; i < split_index; i++)
            for (auto j = 0; j < split_index; j++)
            {
                a00[i][j] = matrix_A[i][j];
```



```
                a01[i][j] = matrix_A[i][j + split_index];
                a10[i][j] = matrix_A[split_index + i][j];
                a11[i][j] = matrix_A[i + split_index]
                                    [j + split_index];
                b00[i][j] = matrix_B[i][j];
                b01[i][j] = matrix_B[i][j + split_index];
                b10[i][j] = matrix_B[split_index + i][j];
                b11[i][j] = matrix_B[i + split_index]
                                    [j + split_index];
            }

        vector<vector<int>> p(multiply_matrix(
            a00, add_matrix(b01, b11, split_index, -1)));
        vector<vector<int>> q(multiply_matrix(
            add_matrix(a00, a01, split_index), b11));
        vector<vector<int>> r(multiply_matrix(
            add_matrix(a10, a11, split_index), b00));
        vector<vector<int>> s(multiply_matrix(
            a11, add_matrix(b10, b00, split_index, -1)));

        vector<vector<int>> t(multiply_matrix(add_matrix(a00, a11, split_index),
add_matrix(b00, b11, split_index)));
        vector<vector<int>> u(multiply_matrix(add_matrix(a01, a11, split_index, -
1), add_matrix(b10, b11, split_index)));
        vector<vector<int>> v(multiply_matrix(add_matrix(a00, a10, split_index, -
1), add_matrix(b00, b01, split_index)));

        vector<vector<int>> result_matrix_00(add_matrix(add_matrix(add_matrix(t,
s, split_index), u,
                                                                   split_index),
                                                        q, split_index, -1));
        vector<vector<int>> result_matrix_01(add_matrix(p, q, split_index));
        vector<vector<int>> result_matrix_10(add_matrix(r, s, split_index));
        vector<vector<int>> result_matrix_11(add_matrix(add_matrix(add_matrix(t,
p, split_index), r,
                                                                   split_index, -
1),
                                                        v, split_index, -1));

        for (auto i = 0; i < split_index; i++)
            for (auto j = 0; j < split_index; j++)
            {
                result_matrix[i][j] = result_matrix_00[i][j];
                result_matrix[i][j + split_index] = result_matrix_01[i][j];
                result_matrix[split_index + i][j] = result_matrix_10[i][j];
```



```
                result_matrix[i + split_index]
                             [j + split_index] = result_matrix_11[i][j];
            }

        a00.clear();
        a01.clear();
        a10.clear();
        a11.clear();
        b00.clear();
        b01.clear();
        b10.clear();
        b11.clear();
        p.clear();
        q.clear();
        r.clear();
        s.clear();
        t.clear();
        u.clear();
        v.clear();
        result_matrix_00.clear();
        result_matrix_01.clear();
        result_matrix_10.clear();
        result_matrix_11.clear();
    }
    return result_matrix;
}

int main()
{
    vector<vector<int>> matrix_A = {{1, 1, 1, 1},
                                    {2, 2, 2, 2},
                                    {3, 3, 3, 3},
                                    {2, 2, 2, 2}};

    print("Array A", matrix_A, 0, 0, ROW_1 - 1, COL_1 - 1);

    vector<vector<int>> matrix_B = {{1, 1, 1, 1},
                                    {2, 2, 2, 2},
                                    {3, 3, 3, 3},
                                    {2, 2, 2, 2}};
    print("Array B", matrix_B, 0, 0, ROW_2 - 1, COL_2 - 1);
    vector<vector<int>> result_matrix(
        multiply_matrix(matrix_A, matrix_B));

    print("Result Array", result_matrix, 0, 0, ROW_1 - 1,
          COL_2 - 1);
}

// Time Complexity: T(N) = 7T(N/2) + O(N^2) => O(N^Log7)
// which is approximately O(N^2.8074) Code Contributed By:
// lucasletum
```

OUTPUT:

```
Array A =>

    1    1    1    1

    2    2    2    2

    3    3    3    3

    2    2    2    2



Array B =>

    1    1    1    1

    2    2    2    2

    3    3    3    3

    2    2    2    2



Result Array =>

    8    8    8    8

    16   16   16   16

    24   24   24   24

    16   16   16   16
```