AHSANIA MISSION UNIVERSITY OF SCIENCE & TECHNOLOGY

Lab Report-2

Lab No: 02

Course Code: CSE 2202

Course Title: Computer Algorithm Sessional.

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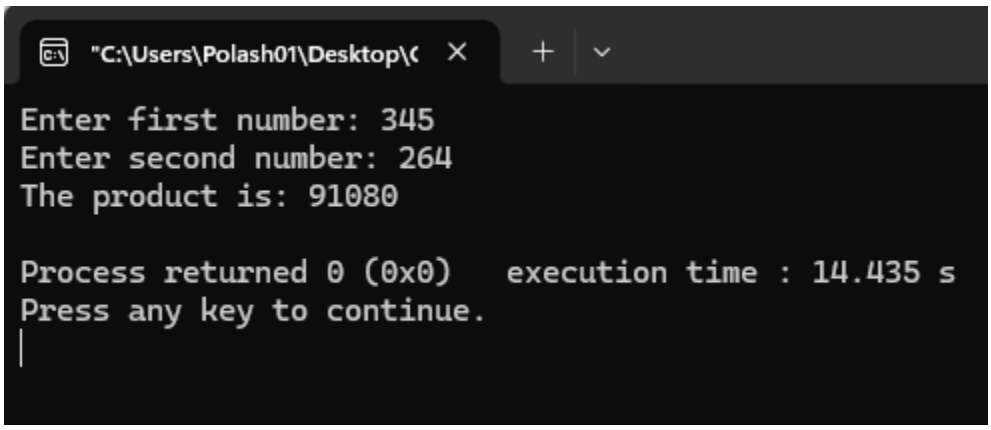
Task01: Karatsuba Multiplication

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

int get_size(long value) {
   int count = 0;
   while (value > 0) {
      count++;
      value /= 10;
   }
   return count;
}

long karatsuba(long X, long Y) {
   if (X < 10 && Y < 10)
      return X * Y;

   int size = fmax(get_size(X), get_size(Y));
   if (size < 10)
      return X * Y;

   size = (size / 2) + (size % 2);
   long multiplier = pow(10, size);

   long b = X / multiplier;
   long a = X - (b * multiplier);
   long d = Y / multiplier;
   long c = Y - (d * multiplier);  // fixed

   long u = karatsuba(a, c);
   long z = karatsuba(a + b, c + d);
   long v = karatsuba(b, d);

   return u + ((z - u - v) * multiplier) + (v * (long)(pow(10, 2 * size)));
}

int main() {
   long x, y;
   cout << "Enter first number: ";
   cin >> x;
   cout << "Enter second number: ";
   cin >> y;
   long result = karatsuba(x, y);
```

```
    cout << "The product is: " << result << endl;
    return 0;
}
```

Output:



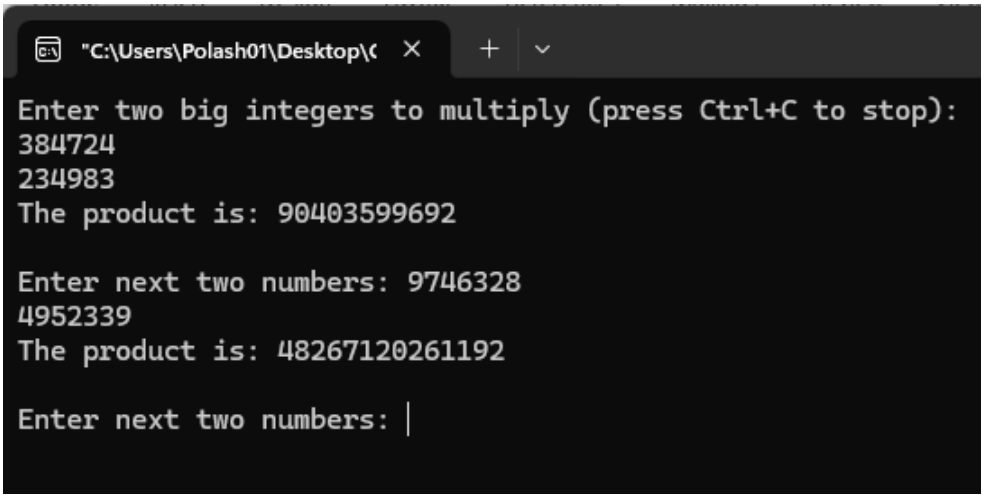
Task02: Grade School Implementation

Source Code

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

int main() {
    string x, y;
    cout << "Enter two big integers to multiply (press Ctrl+C to stop):" << endl;
    while (cin >> x >> y) {
        reverse(x.begin(), x.end());
        reverse(y.begin(), y.end());
        int arr[600] = {0};

        for (int i = 0; i < x.size(); i++) {
            for (int j = 0; j < y.size(); ++j) {
                arr[i + j] += (x[i] - '0') * (y[j] - '0');
            }
        }

        for (int i = 0; i < 599; ++i) {
            arr[i + 1] += arr[i] / 10;
            arr[i] %= 10;
        }
```

```
  bool flag = false;
      cout << "The product is: ";
      for (int i = 599; i >= 0; --i) {
         if (arr[i]) flag = true;
         if (flag) cout << arr[i];
      }
      if (!flag) cout << 0;
      cout << "\n\nEnter next two numbers: ";
   }
}
```

Output:



Task 3: Karatsuba Multiplication (String Version for Large Numbers)

Source Code:

```
#include <iostream>
#include <sstream>
#include <string>
using namespace std;

string String_itoa(int x) {
   stringstream s;
   s << x;
   string return_value;
   s >> return_value;
   return return_value;
}

string RemoveZeros(string x) {
   int c = 0, size = x.size();
   for (int i = 0; i < size; ++i) {
```

```
        if (x[i] == '0') c++;
        else break;
    }
    if (c == size) return "0";
    return x.substr(c, size - c);
}

void AppendZeros(string &x, string &y) {
    int size_x = x.size(), size_y = y.size();
    string append_zeros = "";
    for (int i = 0; i < abs(size_x - size_y); ++i) {
        append_zeros += "0";
    }
    size_x < size_y ? x = append_zeros + x : y = append_zeros + y;
}

string Add(string x, string y) {
    AppendZeros(x, y);
    int remainder = 0, size = x.size();
    for (int i = size - 1; i >= 0; --i) {
        int addition = remainder + int(x[i] - '0') + int(y[i] - '0');
        x[i] = char((addition % 10) + '0');
        remainder = addition / 10;
    }
    if (remainder > 0) x = String_itoa(remainder) + x;
    return x;
}

string Subtract(string x, string y) {
    AppendZeros(x, y);
    int size = x.size();
    for (int i = size - 1; i >= 0; --i) {
        if (x[i] - y[i] >= 0) x[i] = char((x[i] - y[i]) + '0');
        else {
            x[i - 1]--;
            x[i] = char((10 + x[i] - y[i]) + '0');
        }
    }
    return x;
}

string Shift(int value, string x) {
    for (int i = 0; i < value; ++i)
        x += "0";
    return x;
}

string Karatsuba(string x, string y);
```

```
string Multiply(string x, string y) {
   AppendZeros(x, y);
   if (x.size() == 1)
      return String_itoa((x[0] - '0') * (y[0] - '0'));
   else
      return Karatsuba(x, y);
}

string Karatsuba(string x, string y) {
   int n = x.size();
   string a = "", b = "", c = "", d = "";

   for (int i = 0; i < n; ++i) {
      if (i < n / 2 + (n & 1)) {
         a += x[i]; c += y[i];
      } else {
         b += x[i]; d += y[i];
      }
   }

   string ac = Multiply(a, c);
   string bd = Multiply(b, d);
   string ab_cd = Multiply(Add(a, b), Add(c, d));
   string ad_plus_bc = Subtract(ab_cd, Add(ac, bd));

   return Add(Shift(n - (n & 1), ac), Add(Shift(n / 2, ad_plus_bc), bd));
}

int main() {
   string x, y;
   cout << "Enter two large integers to multiply (Ctrl+C to stop):" << endl;
   while (cin >> x >> y) {
      string result = Multiply(x, y);
      cout << "The product is: " << RemoveZeros(result) << endl << endl;
      cout << "Enter next two numbers: ";
   }
}
```

Output: