TP 3 - Problem 1 - I

```
1   #include <cassert>
2   #include <iostream>
3
4   #define SHOW(arg) std::cout << "Macro SHOW “" #arg "”: " << (arg) << '\n';
5
6   class DefInt {
7   public:
8     // Ctor.
9     DefInt(double a, double b, double (*f)(double))
10        : a_{a}, b_{b}, fun_ptr_{f} {
11      assert(a < b);
12    }
13    // Compute the definite integral by trapezoid approximation:
14    //         h/2 [f(x_0) + 2*f(x_1) + ... + 2*f(x_N-1) + f(x_N)]
15    // with h = (b-a)/N and x_n = a + n h, n = 0, ..., N.
16    double ByTrapezoid(int N) {
17      assert(N >= 3);
18      double df{(*fun_ptr_)(a_)};
19      for (int i{1}; i < N; ++i)
```

TP 3 - Problem 1 - II

```
20          // Do not use the “a + n h” expression as errors are cumulative.
21          df += 2 * (*fun_ptr_)(((1 - i) * a_ + i * b_) / N);
22        df += (*fun_ptr_)(b_);
23        return (b_ - a_) / N / 2 * df;
24      }
25      // Compute the definite integral by Simpson approximation:
26      //          (b-a)/6 {f(a) + 4f[(a+b)/2] + f(b)}.
27      double BySimpson() {
28        return (b_ - a_) / 6 *
29               ((*fun_ptr_)(a_) + 4 * (*fun_ptr_)((a_ + b_) / 2) +
30                (*fun_ptr_)(b_));
31      }
32
33    private:
34      double const a_;
35      double const b_;
36      double (*const fun_ptr_)(double);
37    };
38
39    double f(double x) { return 1; }
```

TP 3 - Problem 1 - III

```
40  double g(double x) { return x; }
41  double h(double x) { return x * x; }
42
43  int main() {
44    DefInt def_int_f_0_2{0, 2, f};
45    SHOW(def_int_f_0_2.ByTrapezoid(10))
46    SHOW(def_int_f_0_2.BySimpson())
47    DefInt def_int_g_0_2{0, 2, g};
48    SHOW(def_int_g_0_2.ByTrapezoid(10))
49    SHOW(def_int_g_0_2.BySimpson())
50    DefInt def_int_h_0_2{0, 2, h};
51    SHOW(def_int_h_0_2.ByTrapezoid(10))
52    SHOW(def_int_h_0_2.BySimpson())
53    return 0;
54  }
```

TP 3 - Problem 1 - IV

Output:

```
1  Macro SHOW “def_int_f_0_2.ByTrapezoid(10)”: 2
2  Macro SHOW “def_int_f_0_2.BySimpson()”: 2
3  Macro SHOW “def_int_g_0_2.ByTrapezoid(10)”: 2
4  Macro SHOW “def_int_g_0_2.BySimpson()”: 2
5  Macro SHOW “def_int_h_0_2.ByTrapezoid(10)”: 2.68
6  Macro SHOW “def_int_h_0_2.BySimpson()”: 2.66667
```