Question 1 (20 marks)

Although omitted, assume that all following small programs starts with the two lines of code:

#include <iostream>

using namespace std;

Each of the following small programs has one error which the compiler can detect, therefore it will not compile. Find the error and explain it.

1. 5 marks

struct A { int x; };

class B : A { int y; };

int main()

{

B b;

b.x = 5;

cout << b.x << endl;

return 0;

}

1. 5 marks

struct A { void foo() { cout << "I am an object of type A\n"; } };

int main()

{

const A a;

a.foo();

return 0;

}

1. 5 marks

struct A {

int x;

protected:

A() : x(0) {};

};

int main()

{

A a;

a.x = 5;

cout << a.x << endl;

return 0;

}

1. 5 marks

int main()

{

const int x[] = {1,3,4};

x[2] = 5;

cout << x[2] << endl;

return 0;

}

Question 2 (20 marks)

Although omitted, assume that all following small programs have the correct ***include*** and ***using*** statements (e.g. ***include <iostream a>*** and ***using namespace std***.).

Each of the following small programs has one error which the compiler cannot detect, but that will cause problems at runtime. Find the error and explain it.

1. 8 marks

const unsigned \*randVec(unsigned n)

{

unsigned \*p = new unsigned[n];

for(int i = 0; i < n; ++i)

p[i] = rand() % 1000;

std::sort(p, p+n);

return p;

}

int main()

{

while(true) {

unsigned n;

cout << "Input sample size (or 0 to terminate): ";

cin >> n; // assume the user always enter valid integers, i.e. no error in this line

if (!n)

break;

const unsigned \*p = randVec(n);

unsigned n2 = n/2;

double median = (n % 2)? 1.0\*p[n2]: (p[n2-1]+p[n2])/2.0;

cout << "The median is: " << median << "\n";

}

}

1. 4 marks

int main()

{

const int n = 9;

int s = 0;

int x[n] = {1,2,3,4,5,6,7,8,9};

for( int i = 0; i < n; i += 2 )

s = s + x[i]\*x[i+1];

cout << s << endl;

return 0;

}

1. 4 marks

int main()

{

unsigned n = 5, s = 0;

while( n >= 0 )

s += n--;

cout << s << endl;

return 0;

}

1. 4 marks

unsigned sumFirstN(unsigned n) { return n + sumFirstN(n-1); }

int main()

{

unsigned x = sumFirstN(5);

cout << x << endl;

return 0;

}

Question 3 (8 marks)

Trace step by step all variables (n, a, b, i) and the output of the following program:

#include <iostream>

#include <algorithm>

using namespace std;

int main()

{

const unsigned n = 6;

unsigned a = 0;

unsigned b = 1;

for (unsigned i = 2; i <= 5; ++i) {

a += b;

swap(a, b);

}

cout << b << "\n";

return 0;

}

Question 4 (8 marks)

What output does the following program generate?

#include <iostream>

using namespace std;

unsigned foo(unsigned m, unsigned j)

{

return j? m\*foo(m, j-1): 1;

}

int main()

{

cout << "the result is: " << foo(2, 5) << endl;

return 0;

}

Question 5 (8 marks)

What output does the following program generate?

struct A

{

A() : x(0) {}

virtual void foo()

{

cout << "A: " << x++ << endl;

}

void bar()

{

cout << "A: " << (x+=5) << endl;

}

int x;

};

struct B : A

{

B() : y(10) {}

void foo()

{

cout << "B: " << ++y << endl;

A::foo();

}

void bar()

{

cout << "B: " << (y-=3) << endl;

A::bar();

}

int y;

};

int main()

{

B b;

A& a(b);

a.bar();

b.bar();

a.foo();

b.foo();

}

Question 6 (12 marks)

Fibonacci numbers are defined as defined as:

F1=1, F2=1, Fn=Fn-1+Fn-2

This lead to the sequence: 1, 1, 2, 3, 5, 8, ...

Implement a recursive function with the HEAD specified below which compute **recursively** the n-th Fibinacci number.

unsigned fibonacci(unsigned n);

Example: fibonacci(6) should return 8

Question 7 (12 marks)

Implement a function which computes the product of a matrix A by a vector b and store the result in a vector c. The HEAD of the function is specified below

// compute the matrix vector product c = A b

void MatVecMult

( const double \*A // pointer to a matrix is stored in row-major format, i.e. A(i,j)=A[j+i\*m]

, const double \*b // pointer to vector b (stored contiguously)

, double \*c // pointer to result vector c (stored contiguously)

, size\_t n // number of rows

, size\_t m // number of columns

);

Question 8 (12 marks)

a) (5 marks)

Describe in source code the following hierarchy:

class A has:

* a private member “**x**” of type “**int**”,
* a protected default constructor which initialize “**x**” to zero
* a protected constructor which takes an argument of type “**int**” and initializes “**x**” to the value of the argument
* a public pure virtual method named “**foo***”*with **void** return type
* a protected constant method named “**get**” which returns the value of “**x**”

class B inherits public from class A and has:

* a public default constructor, which invokes the default constructor for A
* a public constructor which takes an argument of type “**int**” and passes it to the constructor of A
* it implements the virtual method “**foo**” printing out the result of a call to “**get**”

b) (4 marks)

* Is A an abstract class?
* Is B an abstract class?
* In the main function, is following statement correct: **A a;**

Explain your answers.

b) (3 marks)

Implement a main function where:

* an object of type B is constructed on the stack (i.e. do not use new) assigning the value 5 to the member “**x**”
* the reference to the object is assigned to a variable “**a**” of type A&
* the method “**foo**” is invoked using the variable “**a**”