Exam. 2 hours, open book.

Exercise 1 (2pt)

a) What is the output when the following code fragment is executed?

```
int n, k = 3;
n = (21% k ? k + 1 : k – 1);
cout << "n = " << n << "    k = " << k << endl;
```

b) What is the output of the following program ?

```
1     #include <iostream>
2     using namespace std;
3     main()
4     {
5        enum weekday
6         {monday, tuesday, wednesday, thursday, friday, saturday,   sunday};
7        weekday today = monday;
8        weekday tomorow = tuesday;
9        cout << today << "  " << tomorow << endl;
10       return 0;
11    }
```

Exercise 2 (4pt)

a) Write a program that ask the user to input 10 integer, that must be stored in an array. The program must then ask for an other integer K. The program must find out if K is in the array and if yes print the index of the position of K in the array.

b) Write a function called sumoneto, that take one integer n as an input, and return the sum of all integer from 1 to n. (for example sumeneto(5) should return 15)

c) The function *mean* is declared the following way.

```
1        double mean(int *val, int n);
```

where *val* is a pointer to the beginning of an array and *n* the size of the array. The return value is the mean value of the values inside the array.

For example it can be use in the following main program :

```
1     int main(){
2     int a[] = {1,2,5,6,7}
3     std::cout << mean (a, 5) << std::endl;
4     }
```

Write an implementation of the mean function.

Exercise 3 (2pt)

a) The following function won't compile. Explain why.

```
1     void foo(const int & a){
2         a+=1;
3         return;}
```

b) Write the output of the following program. Explain the difference between the functions swap1 and swap 2.

```
1       #include <iostream>
2       void swap1(int a, int b){
3           int tmp = a;
4           a =b;
5           b=tmp;
6       };
7
8       void swap2(int &a, int & b){
9           int tmp = a;
10          a =b;
11          b=tmp;
12      };
13
14      int main(){
15          int a =1;
16          int b= 2;
17          std::cout << a << " " << b << std::endl;
18          swap1 ( a, b);
19          std::cout << a << " " << b << std::endl;
20          swap2 (a, b);
21          std::cout << a << " " << b << std::endl;
22      }
```

Exercise 4 (2pt)

a) What is the output of the following program ? Explain the statement (*pb) ++; on line 5

```
1       #include <iostream>
2       int main(){
3           int a =2;
4           int * pb = &a;
5           (*pb) ++;
6           std::cout << a << std::endl;
7       }
```

b) Study the following program. Tell which instruction line change the content of array *numbers* and what are the values of *numbers* that are changed after those instruction. What is the output of the program?

```
1       int main(){
2       int numbers[5]={0,0,0,0,0};
3       int * p;..........................
4       p = numbers;......................
5       *p = 2;...........................
6       p++;..........................
7       *p = 4;..........................
8       p = &numbers[2];..................
9       *p = 6;...........................
10      p = numbers + 2;..................
11      *p = 8;...........................
12      p = numbers;......................
13      *(p+4) = 10;......................
14      for (int n=0; n<5; n++)...........
15          cout << numbers[n] << ", ";...
16      }
```

Exercise 5 (4pt)

a) The following is the declaration of a class found in a *vector3d.h* file:

```
1       class vector3d{
2       public :
3           vector3d(double _x, double _y, double _z);
4           double norm() const;
5       }
6       private :
7           double x, y,z;
8       }
```

The private variable x, y, and z represent the cartesian coordinates of the vector stored in an object of the class vector3.
- Write an implementation of the constructor of vector3d in a separate *vector3d.cc* file. The private variable x, y, z must have the value of _x, _y and _z after construction.
- The member function *norm* is declared const. Explain what it means.
- This member function is supposed to return the norm (length) of the vector. Write an implementation of this function in the vector3d.cc file.

The class vector3d is now used in the following program:

```
1       #include "vector3d.h"
2       int main() {
3           vector3d  v(1., 0., 1.);
4           v.x =2.;
5       }
```

- This program won't compile. Explain why.

b) Design a class called **point** allowing to manipulate a point in a two dimensional space, following the following requirement:
- a point is defined by it's coordinates x and y (private membrers).

- a constructor.

- a member function move, moving a point by adding dx and dy given as argument, to x and y.

- a member function print that display on screen the coordinates of the point.

- a member function input that ask for new coordinates for the point.

- a function distance that compute the distance beetween 2 points

- a function middle that return a point in the middle of two points passed has argument.

You must write your proposal in two separate files: point.h that contain the declaration of the class point. And point .cc where the implementation is.

Exercise 6 (3 pts).

a) Explain what is a derived class, and describe how to implement one in c++.
b) Explain what is a virtual function.
c) Here is a simple class hierarchy, made of a base class call *base* and a derived class *deri*.

```
1       #include <iostream>
2       using namespace std;
3       class base {
4        public:
5          void test(){ cout << "123"    << endl; }
```

```
6          virtual void test_v() { cout << "456" << endl; }
7        };
8
9        class deri : public base {
10        public:
11        void test()    { cout << "789"    << endl; }
12        virtual void test_v() { cout << "101112" << endl; }
13       };
```

This class hierarchy is used in the following main program :

```
1        int main() {
2         base b;
3         deri d;
4         base *pb;
5         deri *pd;
6         b.test();
7         b.test_v();
8         d.test();
9         d.test_v();
10        pb = &b;
11        pb->test();
12        pb->test_v();
13        pb = &d;
14        pb->test();
15        pb->test_v();
16        pd = &d;
17        pd->test();
18        pd->test_v();
19       }
```

- What are the output of the program ?

Exercise 7 (3 pts)

a) What is a template parameter ?

b) What is a function template ?

c) Here is a simple function template :

```
1        template <class myType>
2        myType GetMin (myType a, myType b) {
3            return (a<b?a:b);
4        };
```

- What are the requirements on the template parameter myType for the function GetMax to be use for a given type ?
- Write a main program that use the function GetMin to compare two double.
- The following bit of code won't compile, explain why :

```
1        int x=2;
2        double y=3.5;
3        double z = GetMin(x, y);
```