Examination Guide

Contents

1. Objectives

- Solve small/medium scale problems using Object-Oriented Programming.
- Explain class structures as fundamental, modular building blocks.
- Understand the role of inheritance, polymorphism, dynamic binding and generic structures in building reusable code
- Use classes written by other programmers, use libraries (STL).
- Write small/medium scale C++ programs with simple graphical user interfaces.

2. Course Contents

1. C Programming Language Fundamentals
2. Functions, Modular Programming and Memory Management in C
3. Object-Oriented Programming, Classes and Objects in C++
4. Templates, C++ Standard Template Library
5. Inheritance, UML diagrams
6. Polymorphism
7. I/O Streams, Exception handling
8. RAII, Smart Pointers in STL
9. Qt framework
10. Signals and slots in Qt
11. Model/View Architecture
12. Model/View Architecture, Design Patterns
13. Design Patterns
14. Revision

3. EVALUATION

3.1. During the semester

Lab grade – **L (40% of the final grade)**:

- 50%: Lab assignments: weighted arithmetic mean of 10 lab assignments, with 0 for the labs you did not present.
- 50%: 3 practical tests during the labs (10%, 15%, 25%)
- Additional work: laboratory bonus - LB – **this is added to the final grade**.

The precondition to attend the examination in the regular session is: L ≥ 5 (no rounding).

Seminar bonus – **SB**: 0 – 0.5 – optional bonus for your activity during the seminars. **This is added to the final grade.**

3.2. During the examination session

Written examination – **W (30% of the final grade)**: on your examination date.

Practical examination – **P (30% of the final grade)**: on your examination date, after the written examination.

Final Grade: G = 0.4 x L + 0.3 x P + 0.3 x W + LB + SB

To pass the examination all grades (L, W, P) must be ≥ 5 (no rounding).

3.3. During the retake session

- The final grade in the retake session is computed by the same algorithm presented above.
- During the retake session you can hand in laboratory work, but are limited to a maximum laboratory grade (**L**) of 5.00. *All lab assignments should be properly solved in order to receive 5.*
- You can choose to retake the written, practical, or both examinations in case you have failed/not attended during the regular examination session.
- If you want to increase the grade you obtained during the regular session, you may participate to the examinations during the retake session. Your final grade will be the highest one between those obtained.

4. EXAMINATION DATES

	12.06.2023	21.06.2023	27.06.2023	28.06.2023	Retake - 11.07.2023
Groups (main date)	917 + retake students	911, 915	912, 914	913, 916	All groups
Groups (backup date)	911, 915	912, 914	913, 916	917	All groups
Time for written exam	09:00	09:00	09:00	09:00	09:00
Room(s) for written exam	L001, L002	C310, L320	C335, L321	C335, L321	C335, L320, L321
Time for practical exam	11:30	11:30	11:30	11:30	11:30
Rooms for practical exam	L320, L321, L301	L301, L302, L306, L307	L301, L302, L306, L307	L301, L302, L306, L307	L301, L302, L306, L307

Important rules and observations:

- Attending the examination this year (normal or retake session) is only possible if you fulfill the attendance criterion (5 for seminar activities, 12 for laboratory activities).
- A grade < 5 for the laboratory activity implies that you are not allowed to take the examination during the normal session. You can take the exam during the retake session (see Section 3.3 for more details).
- Make sure you've fulfilled your financial obligations towards the University, otherwise we are not allowed to grade you.
- To take the exam on the backup date, you need a very good reason. In such situations, write me a message on Microsoft Teams **at least 48h beforehand!**
- Re-check the date/time of the exam beforehand.
- Arrive at least 5 minutes earlier and bring a photo ID.
- Both the written and the practical exam take place in the same day, first written, then practical, with a break in between.
- Bring your laptop, if possible. If not, let me know in advance that you will need a university computer. In this case you will have the possibility to use Qt and Qt Creator.
- Do not plagiarize! Plagiarism involves examination failing (you cannot retake the examination, not even during the retake session).

Suggestions:

- Make sure you rest the night before the examination, but do not forget to set your alarm clock (several alarms).
- You will be at the faculty many hours in the exam day, so make sure you have something to eat and drink.
- Try to pay attention to the explanations I give at the beginning of each exam, about the requirements.
- Do not stress too much. You have more chances to take the examination (retake, then you still have the following years, if necessary).

5. Written Examination

This will last approximately 1 – 1.25 hours.

5.1. OOP concepts – C++

- templates, STL (containers, algorithms, iterators, smart pointers);
- dynamic memory allocation;
- constructors, destructors, inheritance, virtual methods, abstract class, operator overloading, static, friend elements;
- input/output streams;
- exceptions;

Given the test function below, implement the class **Stack**. Specify the method which adds an element to the stack.

```
void testStack()
{
	Stack<std::string> s{ 2 };
	assert(s.getMaxCapacity() == 2);
	try	{
		s = s + "examination";
		s = s + "oop";
		s = s + "test";
	}
	catch (std::exception& e) {
		assert(strcmp(e.what(), "Stack is full!") == 0);
	}
	assert(s.pop() == "oop");
	assert(s.pop() == "examination");
}
```

Define the classes “ToDo” and “Activity” such that the following C++ code is correct and its results are the ones indicated in the comments.

```
void ToDoList()
{
	ToDo<Activity> todo{};
	Activity tiff{ "go to TIFF movie", "20:00" };
	todo += tiff;
	Activity project{ "present project assignment", "09.20" };
	todo += project;

	// iterates through the activities and prints them as follows:
	// Activity go to TIFF movie will take place at 20.00.
	// Activity present project assignment will take place at 09.20.
	for (auto a : todo)
		std::cout << a << '\n';

	// Prints the activities as follows:
	// Activity present project assignment will take place at 09.20.
	// Activity go to TIFF movie will take place at 20.00.
	todo.reversePrint(std::cout);
}
```

Determine the result of the execution of the following C++ programs. If there are any errors, signal them, correct them and explain the result after the error has been corrected. Justify your answers.

```
class B
{
public:
	B() { std::cout << "B{}"; }
	virtual void print() { std::cout <<
"B"; }
	virtual ~B() { std::cout << "~B()"; }
};

class D : public B
{
public:
	D() { std::cout << "D{}"; }
	void print() override { std::cout <<
"D"; }
	virtual ~D() { std::cout << "~D()"; }
};
```

```
int main()
{
	B* b[] = { new B{}, new D{} };
	b[0]->print();
	b[1]->print();
	delete b[0];
	delete b[1];
	return 0;
}
```

```cpp
class Person
{
public:
	Person() { std::cout << "Person{}"; }
	virtual void print() = 0;
	virtual ~Person() { std::cout <<
"~Person()"; }
};

class Student : public Person
{
public:
	Student() { std::cout << "Student{}";
}
	void print() override { std::cout <<
"Student"; }
	virtual ~Student() { std::cout <<
"~Student()"; }
};
```

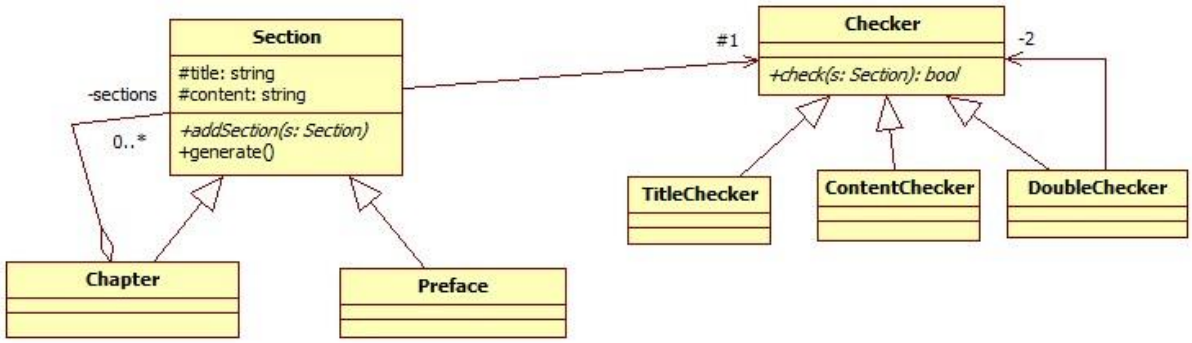
```cpp
int main()
{
	Person* p = new Person{};
	delete p;
	Person* s = new Student{};
	s->print();
	delete s;

	return 0;
}
```

```cpp
class E
{
public:
	E() { std::cout << "E{}"; }
	virtual ~E() { std::cout << "~E()"; }
};

class DE : public E
{
public:
	static int n;
	DE() { n++; }
};

int DE::n = 0;



int fct2(int x)
{
	if (x < 0)
	{
		throw E{};
		std::cout << "number less than
0" << std::endl;
	}
	else if (x == 0)
	{
		throw DE{};
		std::cout << "number equal to 0"
<< std::endl;
	}
	return x % 10;
}
```

```cpp
int main()
{
	try
	{
		int res = 0;
		res = fct2(-5);
		std::cout << DE::n;
		res = fct2(0);
		std::cout << DE::n;
		res = fct2(25);
		std::cout << DE::n;
	}
	catch (E&)
	{
		std::cout << DE::n;
	}

	return 0;
}
```

5.2. Inheritance, polymorphism, UML, design patterns – C++

1. Write a C++ application for generating a book when several chapters are given **(4p)**, as follows:
   a. The class **Checker** is abstract, it contains the pure virtual function *check*, which checks if the given section is correct. **(0.2p)**
   b. The classes **TitleChecker** and **ContentChecker** check the title and the content of the given section, respectively. The function *check* in **TitleChecker** returns true is the section title is longer than 2 characters. The function *check* in **ContentChecker** returns true if each sentence in the content begins with a capital letter (hint: function *isupper(char)*). **(0.5p)**
   c. Create the class **DoubleChecker**. Its function *check* returns true only if the section is correct (check returns true), from the point of view of both aggregated checkers. **(0.5p)**
   d. Create the class **Section**, with abstract function *addSection*. The function *generate* prints the title and content of the section only if the section is correct from the point of view of the aggregated checker. (**0.7p**)
   e. Create the class **Preface**. A preface cannot have any aggregated sections. **(0.3p)**
   f. Create the class **Chapter**. The function generate in the class **Chapter** will generate the chapter only if its title and content are correct and will include only those aggregated sections that are correct (checked). **(0.7p)**
   g. Generate a book, which contains: a preface (checked by content, with a content checker); a chapter (checked by title, with a title checker), which contains 2 subchapters, both checked by title and by content; the first chapter passes the check, while the second does not. Make sure the memory is correctly managed. **(1.1p)**



6. PRACTICAL EXAMINATION

This will last approximately 2.5 hours.

Below you will find a problem statement similar to what you can expect to receive during the practical examination. The problem statement will in general follow the requirements set out between Assignment 4 and Assignment 10, will require reading and writing from/to a file, data validation, a graphical user interface (using Qt), the implementation of layered architecture, Observer, Model/View architecture, simple drawing in Qt and may require writing specifications and tests.

Observations:

1. Solving the following problem statement completely should be possible for you in a time span of 2.5 hours.

2. You are encouraged to bring your own laptop to the exam. You are free to use your preferred IDE. Make sure your IDE is set up correctly and it works! Make sure that Qt works! If you cannot bring a laptop, you can use university computers (Qt and Qt Creator). For this, please let me know at least one day in advance that you will be using a university computer.

3. You are allowed to use Qt Designer, if you want to.

4. Only functional features are scored (non-functional source code is not scored).

5. The problem must be started from an empty workspace. You are allowed to use the following sites for documentation, but nothing else:
- http://doc.qt.io/qt-6/
- http://en.cppreference.com/w/
- http://www.cplusplus.com/

6.1. Problem statement

Write an application which simulates the development and testing of a software application, as follows:

1. The information about the development team is in a text file. Each member of the team ***- User*** has **a name** (string) and **a type** (string), which indicates whether the user is *a tester* or *a programmer*. This file is manually created and it is read when the application starts.
2. Another file contains information about the issues reported by the testers. Each ***Issue*** has **a description** (string), **a status** (can be *open* or *closed)*, **the reporter** – the name of the person who reported it and **the solver** – the name of the person who solved it. These are read when the application starts and are also stored in the file by the program.
3. When the application is launched, a new window is created for each user, having as title the user's name and type (tester or programmer). **(1p)**
4. Each window will show all the issues, with their description, status, reporter and solver, sorted by status and by description. **(1p)**
5. Only testers can report issues, by inputting the issue's description and pressing a button "Add". The issue's reporter will automatically be set – this will be the name of the tester who added it.

This operation fails if the description is empty or if there is another issue with the same description. The user will be informed if the operation fails. **(1.25p)**

6. Both programmers and users can remove issues. An issue can only be removed if its status is *closed*. **(1p)**
7. Only programmers can resolve issues, by selecting the issue and pressing a button "Resolve". This button is activated only if the status of selected issue is *open*. When an issue is resolved, the name of the issue's solver is automatically updated to the name of the programmer who solved it. **(1.25p)**
8. When a modification is made by any user, all the other users will see the modified list of issues. Use the Observer pattern. **(2p)**
9. When the application is finished, the issues file will be updated. **(0.5p)**

Observations

1. **1p - of**
2. Specify and test the following functions (repository / service):
    a. Function which adds an issue. **(0.5p)**
    b. Function which updates an issue's status and programmer. **(0.5p)**
3. The application must use layered architecture in order for functionalities to be graded.
4. If you do not read the data from file, you will receive 50% of functionalities 3, 4, 5 and 6.

6.2. Advice for the practical examination

1. Implement a problem similar to the one in the example (Section **Problem statement**). Time yourself while solving it, make sure you can implement at least some of the functionalities in the allotted time (2.5 hours). This way you can detect where your difficulties are and you can improve yourself.
2. Build your application incrementally: one step at a time, **compile frequently**.
3. Only add one function in one step, so that you can easily revert to a functional version, in case something doesn't work.
4. **Do not ignore the errors**, solve them before continuing with writing source code. **Read the error text!**
5. Do not ignore warnings, sometimes these can indicate errors in the program.
6. Use STL containers and algorithms.
7. **Do not implement functionalities that are not required**. By doing this, you might waste valuable time and **the source code will not be graded, only the functional requirements**!
8. If there are issues that you cannot solve, try finding alternative implementations such that you can still test your code.
9. For the practical examination, build an empty Qt project and make sure that it compiles and that you can execute it (that you have everything set up properly).

7. BIBLIOGRAPHY

1. B. Stroustrup. The C++ Programming Language, Addison Wesley, 1998.
2. Bruce Eckel. Thinking in C++, Prentice Hall, 1995.
3. A. Alexandrescu. Programarea moderna in C++: Programare generica si modele de proiectare aplicate, Editura Teora, 2002.
4. S. Meyers. Effective C++: 55 Specific Ways to Improve Your Programs and Designs (3rd Edition), Addison-Wesley, 2005.
5. S. Meyers. More effective C++: 35 New Ways to Improve Your Programs and Designs, Addison-Wesley, 1995.
6. B. Stroustrup. A Tour of C++, Addison Wesley, 2013.
7. C++ reference (http://en.cppreference.com/w/).
8. Qt Documentation (http://doc.qt.io/qt-5/).
9. E. Gamma, R. Helm, R. Johnson, J. Vlissides. Design Patterns: Elements of Reusable Object-Oriented Software, Addison-Wesley Longman Publishing, 1995.