



## Course Brief and Outline — 2024

### Academic Staff

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### 1 Course Background

This course forms part of the “Software Development” line of courses. It follows on from Software Development I and is a prerequisite for Software Development III. It deepens and broadens students’ technical knowledge and skills with respect to software engineering and development.

### 2 Course Objectives

This course has three main objectives. It introduces the student to object-oriented modelling and design, programming using modern C++, and key software engineering technical practices such as unit testing and version control. More specialized software engineering courses flow from, and build on, the conceptual knowledge and practical skills developed in this course.

### 3 Course Outcomes

On successful completion of this course, the student is able to:

1. describe how C++ fits into the software development ecosystem and the trade-offs that it makes with respect to other programming languages;
2. perform object-oriented analyses of moderately complex software problems;
3. design and implement object-oriented solutions in C++ for such problems;
4. program in C++ in a modern, idiomatic fashion;
5. create a graphical user interface (GUI) using a game programming library;
6. utilise a test framework for software testing and verification;
7. use version control in a simple manner for tracking changes and sharing code;
8. use a formal notation to document a software design as well as an automated documentation tool.

## 4 Course Content

### C++'s Place in the World

Compiled versus interpreted languages; strongly-typed versus weakly-typed languages; language popularity; programming paradigms

### The Development Environment

The Integrated Development Environment (IDE); the build toolchain: pre-processor, compiler, linker; debugging

### C++ Fundamentals

Primitive types, pointers and references; parameter passing; `const`; `static`, smart pointers, `auto`, range-based for loops, tuples

### The C++ Standard Template Library

Containers; iterators; algorithms; vector and string

### Programming Principles and Practices

Readable code, DRY principle, defensive coding, separation of concerns

### Object-Oriented Analysis and Design

Levels of abstraction; interface and implementation; object-oriented analysis and design process; Tell, Don't Ask principle; Liskov substitution principle; code smells; modelling pitfalls

### Object-Oriented Programming in C++

Classes and objects; constructors and destructors; copy construction and assignment; inheritance and polymorphism; aggregation.

### Unit Testing

Automated unit testing, unit-test frameworks, test-driven development; writing good tests

### Version Control

Git and GitHub, commits, fast-forward merges, pull requests, collaboration

### Software Documentation

Unified Modelling Language (UML); class and sequence diagrams; technical documentation; extracting documentation from code

### Error Handling

Exceptions; assertions; pre- and post-conditions; error handling schemes

### Graphical User Interfaces

Game development library; graphics; event handling

## 5 Prior Knowledge Assumed

This course depends on content covered in Software Development I. In particular it assumes that students have a working knowledge of programming fundamentals (in C++). This includes variables; scope; flow control; raw pointers; functions, standalone classes, and the ability to write small programs to solve problems.

The prerequisites and co-requisites to register for this course are defined in the current *Rules & Syllabuses: Faculty of Engineering and the Built Environment*.

## 6 Assessment

### 6.1 Formative Assessment

Although marks are allocated to the assessment of labs (see [Section 6.2](#)) and the attendance at lab review sessions, this is regarded as formative in that the emphasis is on student participation and learning rather than whether the solutions are correct or not. Feedback on labs is provided through comments on each group's source code submissions as well as discussions held during dedicated review sessions.

### 6.2 Summative Assessment

| Assessment Contributor      | Duration (hours) | Component | Method & Weight | Calculator Type | Permitted Supporting Material |
|-----------------------------|------------------|-----------|-----------------|-----------------|-------------------------------|
| Laboratories and Engagement | 33               | No        | Marks, 8%       | –               | –                             |
| Project                     | 30               | No        | Rubric, 28%     | –               | –                             |
| Test                        | 1                | No        | Marks, 24%      | 1               | Reference sheets provided     |
| Examination*                | 3                | No        | Marks, 40%      | 1               | Reference sheets provided     |

\*Note that the end-of-year examination requires a minimum of 35% in order to pass the course (termed a subminimum). This means that even if the average final mark for the course is 50% or above, a final examination mark of less than 35% does not qualify one to pass the course, as per the University Rules and Syllabuses.

### 6.3 Assessment Methods

Students will be assessed working *alone* (test and exam) and in *groups* (labs and project).

The project will require the student to work as part of a team to creatively identify, assess, formulate and solve a software development problem by using concepts, methods, tools and techniques introduced in this course. Additionally, the student must communicate the results critically and effectively by means of a set of group-effort reports using appropriate structure, style and graphical support. A marking rubric will accompany the project brief and this rubric will present the criteria for assessing the project outcomes.

The test is a written test which will take place during the semester. The material to be covered will be indicated by the lecturer.

The final exam will be time-tabled within the Oct/Nov examination period. All the material covered during the course (including lectures, laboratories, additional material, and the course project) is examinable.

The lab review sessions, and the class test and final examination are *mandatory in-person* requirements for this course. Students will be required to attend the lab review sessions and write the test and all examinations (final exam/deferred/supplementary) on the Wits campus at the venue, and scheduled date and time, that is published by the lecturer, School or the Examination and Graduations Office.

## 7 Satisfactory Performance (SP) Requirements

For the purpose of Rule G.13 *satisfactory performance in the work of the class* means the completion of prescribed laboratory activities, submission of assignments, and writing of scheduled tests unless excused in terms of due procedure.

## 8 Teaching and Learning Process

### 8.1 Teaching and Learning Approach

This course is intentionally designed as *hybrid* course embracing the use of both online and in-person teaching and learning modes.

### 8.2 Information to Support the Course

Supporting information for this course can be found on the course website. All the software development tools used during this course are freely available enabling students to use their own computing facilities.

There is no prescribed textbook for this course, although the textbook that is used in Software Development I covers some course material. Many good introductory texts on C++ programming are available in the Engineering and Geo/Maths libraries and at major bookshops. Additionally, there is an enormous amount of material that is accessible on the web. These resources can be used to supplement the course material.

Each of the following books are highly recommended if you wish to delve deeper into the language. *C++ Crash Course* is a concise and modern introduction to C++. *Effective Modern C++* is a very good “morality” guide — focusing on what you should do rather than presenting everything that you can do with C++. *C++ Coding Standards* and the *Core Guidelines* present important guidelines and considerations for C++ developers. Finally, *The C++ Programming Language* is by the creator of C++, Bjarne Stroustrup, and is the best reference for the language.

1. Josh Lospinoso. *C++ Crash Course: A Fast-Paced introduction*. No Starch Press, San Francisco, first edition, 2019
2. Scott Meyers. *Effective Modern C++: 42 Specific Ways to Improve Your Use of C++11 and C++14*. O’Reilly Media, first edition, 2014
3. Herb Sutter and Andrei Alexandrescu. *C++ Coding Standards: 101 Rules, Guidelines, and Best Practices*. C++ In-Depth Series. Addison-Wesley Professional, Berkeley, California, first edition, 2005; along with the [C++ Core Guidelines](#)
4. Bjarne Stroustrup. *The C++ Programming Language*. Addison-Wesley Professional, fourth edition, 2013

### 8.3 Learning Activities and Arrangements

#### Lectures

The course content will be primarily delivered in the form of online videos and online supplementary material. Students are expected to watch the videos, and it will be taken that all material covered in this fashion has been viewed by students. In-person lectures will be highly interactive and will involve working through examples and problems.

## Laboratories

There are a number of in-person laboratories associated with this course. *Doing the laboratories is indispensable for understanding the course material as they help to reinforce the concepts which are covered.* Teaching assistants and the course lecturer will be on hand to provide assistance during the laboratory sessions.

## Project

The project brief will be handed out to the students during the course. It presents an opportunity to apply the course material. Students are required to work in pairs on the project over a number of weeks. Note that the School's policy on the timely submission of projects, as described in the *Red Book*, will be strictly enforced.

## Consultation

Students are expected to consult with the lecturer or teaching assistants during the laboratory sessions or directly after lectures. Students should only contact the lecturer via email with regard to personal matters relating to the course.

## 9 Course Home Page

Further information and announcements regarding the course are posted on Ulwazi and/or the course home page: <https://witseie.github.io/software-dev-2/>

All students are expected to consult the course home page, and their email, at regular intervals.