

Annexe A: New/Revised Course Content in OBTL+ Format

Course Overview

The sections shown on this interface are based on the templates [UG OBTL+](#) or [PG OBTL+](#)

If you are revising/duplicating an existing course and do not see the pre-filled contents you expect in the subsequent sections e.g. Course Aims, Intended Learning Outcomes etc. please refer to [Data Transformation Status](#) for more information.

Expected Implementation in Academic Year	AY2024-2025
Semester/Trimester/Others (specify approx. Start/End date)	Semester 2
Course Author * Faculty proposing/revising the course	Hui Siu Cheung
Course Author Email	asschui@ntu.edu.sg
Course Title	C and C++ Programming
Course Code	SC1008
Academic Units	3
Contact Hours	39
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	SC1003/CE1103/CZ1103 Introduction to Computational Thinking and Programming
Co-requisites	
Pre-requisite to	SC2079 Multidisciplinary Design Project, SC3103 Embedded Programming, SC4067 Software Security
Mutually exclusive to	
Replacement course to	
Remarks (if any)	

Course Aims

Computational thinking and programming using Python are taught in SC1003. However, C is important for system programming and developing embedded systems. It combines the benefits of both low machine level languages and high-level developer friendly languages and is very fast. C++ is widely used in producing gaming engines, virtual reality applications, web browsers, building popular database tools, blockchain technology. This course lays the foundation knowledge in C and C++ programming.

Course's Intended Learning Outcomes (ILOs)

Upon the successful completion of this course, you (student) would be able to:

ILO 1	Design and implement simple C programs using basic programming constructs.
ILO 2	Design and implement pointers, arrays, character strings and structures in C.
ILO 3	Design and implement recursive functions in C.
ILO 4	Design and implement linked lists in C.
ILO 5	Develop object-oriented programs in C++ using classes, inheritance and polymorphism.
ILO 6	Master the usage of common containers of Standard Template Library in C++.

Course Content

Basic Constructs in C Language

C program structure. Syntax and semantics. Intrinsic data types, declarations, operators, assignments, control flow, and simple input/output. Pre-processing. Functions. Return values, arguments and parameter passing. Scopes of variables. Concept of side effects.

Built-in Data Structures

Pointers, pointer operations and pass by reference. One-dimensional and multi-dimensional arrays, and pointers and arrays. Character strings and arrays of strings. Structures, arrays of structures and type definitions.

Recursion

Basic recursion. Problem solving with recursion. Recursive versus iterative functions.

Link Lists

Dynamic memory allocation. Linked list structures and applications.

Basic C++ Programming

C++ Program Structure; Operators and expressions; Types and conversions; Function; Scope; Simple input/output; References; Strings in C++.

Class and Object in C++

Class definition; Constructors and destructors; Class methods; Static class members; Access control or encapsulation; Structures and Unions.

STL Basics in C++

Arrays; vectors.

Inheritance and Polymorphism in C++

Inheritance; Method overloading and overriding; Multilevel inheritance; Multiple inheritance; Virtual functions; Polymorphism.

Reading and References (if applicable)

The course will not use any specific textbook. The following books will be used as reference materials.

1. S.C. Hui, "Introduction to C Programming", Pearson Education South Asia Pte Ltd, 2002.
2. B. Stroustrup, "Programming: principles and practice using C++ (3rd Edition)", Addison-Wesley Professional, 2024.
3. Stanley B. Lippman, Josée Lajoie, Barbara E. Moo, "C++ Primer (5th Edition)", Addison-Wesley Professional, 2012.
4. Tony Gaddis, Judy Walters, Godfrey Muganda, "Starting Out with C++: Early Objects (10th Edition)", 2019.

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	Basic C Programming (C program structure; Syntax and semantics; Intrinsic data types, declarations, operators, assignments, and simple input/output.)	1	Lecture notes and reference books	In-person	Lecture/Tutorial and Lab
2	Control Constructs (Branching constructs; Looping constructs; Procedure/function: activation, parameter passing, scopes of variables, and concept of side effects.)	1	Lecture notes and reference books	In-person	Lecture/Tutorial and Lab
3	Pointers (Pointer types; Pointer operations; Pass by reference.)	1,2	Lecture notes and reference books	In-person	Lecture/Tutorial and Lab
4	Arrays (One-dimensional arrays; Multi-dimensional arrays.)	1,2	Lecture notes and reference books	In-person	Lecture/Tutorial and Lab

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
5	Character Strings (String constants and variables; String input/output; Character functions; String functions; Arrays of strings.)	1,2	Lecture notes and reference books	In-person	Lecture/Tutorial and Lab
6	Structures (Type definitions; Structured types; Arrays of Structures; Nested structures; Enumerated types.)	1,2	Lecture notes and reference books	In-person	Lecture/Tutorial and Lab
7	Recursions (Basic recursion; Problem solving with recursion; Recursive versus iterative functions.)	1,2,3	Lecture notes and reference books	In-person	Lecture/Tutorial and Lab
8	Linked Lists (Static vs dynamic memory allocation; Overview of node-based data structures; Linked list structures and applications.)	4	Lecture notes and reference books	In-person	Lecture/Tutorial and Lab

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
9	Class and Object in C++ (Class definition; Constructors and destructors; Class methods; Static class members; Access control or encapsulation; Structures and Unions.)	5	Lecture notes and reference books	In-person	Lecture/Tutorial and Lab
10	References, STL Arrays and STL Vectors (References vs. pointers; Static and dynamic arrays in C++; STL array; STL vectors.)	6	Lecture notes and reference books	In-person	Lecture/Tutorial and Lab
11	Strings in C++ (The string class in C++; string functions.)	5	Lecture notes and reference books	In-person	Lecture/Tutorial and Lab
12	Inheritance and Polymorphism in C++ (Inheritance; Method overloading and overriding; Multilevel inheritance; Multiple inheritance; Virtual functions; Polymorphism.)	5	Lecture notes and reference books	In-person	Lecture/Tutorial and Lab

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lectures	Topics will be delivered as a series of physical/online lectures, and students will also be provided with reference reading materials for self-study, to achieve ILO 1 to ILO 6.
Tutorials and Labs	Students will apply the programming concepts to problems of different degrees of difficulties during tutorial/lab sessions. These achieve ILO 1 to ILO 6.

Planned no. of hours for learning activities (across entire course)

'Learning activities' refer to the range of activities students will engage in, in-person and online, to acquire the course's intended learning outcomes.

No.	Category	Planned no. of hours
1	<u>Lecture-based sessions</u> Learning activities where primarily, students receive content and perform notetaking.	13
2	<u>Participation-based classroom sessions (Tutorials, Seminars, Studios)</u> Learning activities where primarily, students are expected to engage actively with the instructor, their peers and the content.	13
3	<u>In-house practical sessions (Labs)</u> Learning activities where students engage in hands-on activities to conduct experiments, with the guidance of instructors, alongside peers, within the NTU campus.	13
4	<u>In-house practical sessions (Practicum)</u> Learning activities where students engage in hands-on activities, with the guidance of instructors, alongside peers, within the NTU campus.	0
5	<u>Self/Group learning (without instructor)</u> Learning activities where students are expected to engage in independent learning. For example, preparing for classes, labs and practicum, engaging in readings, completing quizzes or tasks.	20
6	<u>Others</u> Please specify:	0
	Total Planned no. of hours (across entire course)	59

Estimated percentage of hours for online and in-person learning, based on the total estimated no. of learning activity hours (across the semester):

Percentage of hours of Online learning (Includes synchronous and asynchronous learning)	0
Percentage of hours of In-person learning	100

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Assignment()	1,2,3,4,5,6	a,b,c,d,h,l	30	Individual	Analytic	Relational
2	Continuous Assessment (CA): Test/Quiz(Online MCQ)	1,2,3,4,5,6	a,b,c	35	Individual	Analytic	Relational
3	Continuous Assessment (CA): Test/Quiz(Online Coding Questions)	1,2,3,4,5,6	a,b,c,d,h,l	35	Individual	Analytic	Relational

Description of Assessment Components (if applicable)

*The graduate attributes as stipulated by the EAB, are:

- Engineering knowledge: Apply the knowledge of mathematics, natural science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
- Problem Analysis: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- Design/development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
- Investigation: Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- The engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for the sustainable development.
- Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
- Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and economic decision-making, and apply these to one's own work, as a member and

leader in a team, to manage projects and in multidisciplinary environments.

(I) Life-long Learning: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Formative Feedback

You are expected to prepare for the tutorials even though they are not assessed because being able to participate effectively in class can help you to develop the skills and knowledge necessary to succeed in this course. The tutorial questions are often derived from past exams, which means, that cross-generational formative feedback will also be provided by discussing the typical mistakes made by prior batches of students.

During the tutorial, the instructor will answer your questions and, if necessary, send additional notes to further explain the solutions and address your questions after tutorial.

NTU Graduate Attributes/Competency Mapping

This course intends to develop the following graduate attributes and competencies (maximum 5 most relevant)

Attributes/Competency	Level
Communication	Basic
Creative Thinking	Intermediate
Digital Fluency	Advanced
Problem Solving	Advanced
Critical Thinking	Intermediate

Course Policy

Policy (Academic Integrity)

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values. As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. On the use of technological tools (such as Generative AI tools), different courses / assignments have different intended learning outcomes. Students should refer to the specific assignment instructions on their use and requirements and/or consult your instructors on how you can use these tools to help your learning. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Policy (General)

You are expected to complete all assigned readings, activities, assignments, attend all classes punctually and complete all scheduled assignments by due dates. You are expected to take responsibility to follow up with assignments and course related announcements. You are expected to participate in all project critiques, class discussions and activities.

Policy (Absenteeism)

Lab tests and quizzes make up a significant portion of your course grade. Absence from class without a valid reason will result in a zero mark being awarded. Valid reasons include illness, supported by a medical certificate, or participation in NTU's approved activities, supported by an excuse letter from the relevant authorities. Make-up opportunities may be provided.

Policy (Others, if applicable)

As a student of the course, you are required to abide by both the University Code of Conduct and the Student Code of Conduct. The Codes provide information on the responsibilities of all NTU students, as well as examples of misconduct and details about how students can report suspected misconduct. The university also has the Student Mental Health Policy. The Policy states the University's commitment to providing a supportive environment for the holistic development of students, including the improvement of mental health and wellbeing. These policies and codes concerning students can be found in the following link.
<http://www.ntu.edu.sg/SAO/Pages/Policies-concerning-students.aspx>

NTU2025 Education Initiatives

In this course, the following NTU2025 education initiatives are emphasised:

No.	Initiative	Description	Select
1	Interdisciplinary learning	Students learn through applying more than one disciplinary framework to solve problems or examine issues from different perspectives.	<input type="checkbox"/>
2	Collaborative learning	Students learn through sharing and working with one another to solve problems or address issues.	<input type="checkbox"/>
3	Experiential learning	Students learn through activities that have significant elements of observation and reflection of concrete experience .	<input type="checkbox"/>

External Partner

Indicate the organisation's name(s) and describe the nature of involvement e.g., co-curation of course, speaker or instructor (include no. of course hours if known).

No.	Organization Type	Organisation Name	Nature of involvement
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Appendix with Rubric (Assessment Criteria)

Please remember to attach the Appendix with Rubric (Assessment Criteria) if you have uploaded any.

[Appendix 1.pdf](#)

Last Updated Date: 27-09-2024 01:53:13

Last Updated By: Hui Siu Cheung (Assoc Prof)

Please refer to the next page for the current status of approval as captured by the Curriculum Management Application.

Progress of Approval Path

This version of the course details, submitted with the Cover Page, has been approved at the levels of:

Approval Level	Triggered By	Approved Date & Time
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Final Approval Status

The approval process has been completed on , based on the Approval Path shown above.

Note: If no Approval Path is shown above, the Course has been approved through offline means (e.g. routing by emails). Please access the [course](#) in the Curriculum Management Application and refer to its Attachment tab for the necessary approval documents/ communication.