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| **Computer Engineering Department - ITU** |
| **CE101L: Object Oriented Programming Lab** |

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| **Course Instructor: Usama Bin Shakeel** | **Dated:** |
| **Teaching Assistant: Zain** | **Semester: Spring 2023** |
| **Lab Engineer: Rana Hamza Shakil** | **Batch: BSCE2022** |

# **Lab 5A. Deep Copy vs Shallow Copy**

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| **Name** | **Roll number** | **Report**  **(out of 100)** | **Scaled to 10** | **Total**  **(out of 10)** |
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Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

## **Objective**

The objective of this lab is to observe the basic knowledge of programming in C++.

## **Equipment and Component**

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| **Component Description** | **Value** | **Quantity** |
| Computer | Available in lab | 1 |

## **Conduct of Lab**

1. Students are required to perform this experiment individually.
2. In case the lab experiment is not understood, the students are advised to seek help from the course instructor, lab engineers, assigned teaching assistants (TA) and lab attendants.

## **Theory and Background**

**Deep and Shallow Copy**

In C++, shallow copy refers to copying the values of an object's data members to a new object without creating new objects for the object's referenced data. In other words, a shallow copy of an object will only duplicate the object's data members, but not the objects that they reference. The result is that the new object and the original object share the same referenced objects. On the other hand, deep copy refers to creating a completely new and independent copy of an object, including its referenced objects. A deep copy of an object creates new objects for all referenced data, so that the new object and the original object do not share any referenced objects.

In summary, the main difference between shallow copy and deep copy is that shallow copy only copies the values of the object's data members, while deep copy creates a completely new and independent copy of an object, including its referenced objects.

**Lab Task**

**Task A [Marks: 5]**

Please follow the following steps before starting below tasks:

1. Create a separate header file (**.h file**) for each class declaration of data members and member functions

2. Create a separate source file (**.cpp file**) for the implementation of the class member functions.

3. Create **main.cpp** file for creating objects of class and other driving code.

**Task B: Deep Copy Vs Shallow Copy [Marks: 35]**

Create a class named "Invoice" to represent an invoice for a departmental store. The attributes can provide additional information about the invoice which includes: Invoice number (int\*),  Total amount (float\*), Customer ID (int), Customer Phone number (int\*), Order number  (int), itemCount (int\*).

The class should have the following member functions:

* A default constructor that initializes all the data members to default values.
* A parameterized constructor that takes the item name, item description, quantity of the item, and price per item as arguments and initializes the data members accordingly.
* Create a shallow and deep copy constructor that creates a shallow and deep copy of an existing "Invoice" object. The attributes are defined for the invoice at the start of the problem.
* A destructor that deallocates any dynamically allocated memory.
* A display function that outputs the invoice's information to the console.
* A function that calculates the total cost of the invoice by multiplying the quantity of the item by the price per item.

Implement the above member functions and write a main function that demonstrates the shallow and deep copy of "Invoice" objects.

* Create an "Invoice" object using the parameterized constructor and display its information.
* Create a shallow copy of the above "Invoice" object using the shallow copy constructor and display its information.
* Modify the original "Invoice" object's quantity and display the information of both the original object and the shallow copy.
* Create a deep copy of the original "Invoice" object using the deep copy constructor and display its information.
* Modify the original "Invoice" object's quantity and display the information of both the original object and the deep copy.

The output should show the difference between shallow and deep copy in terms of changes made to the original object affecting the copy.

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| // Paste your code here |

### Assessment Rubric for Lab

**Method for assessment:**

Lab reports and instructor observation during lab sessions. Outcome assessed:

a. Ability to conduct experiments, as well as to analyze and interpret data (P) b. Ability to function on multi-disciplinary teams (A)

c. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice (P)

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| **Performance metric** | **Task** | **CLO** | **Description** | **Max marks** | **Exceeds expectation** | **Meets expectation** | **Does not meet expectation** | **Obtained marks** |
| 1. Realization of experiment (a) | 1 | 1 | Functionality | 40 | Executes without errors excellent user prompts, good use of symbols, spacing in output. Through testing has been completed (35-40) | Executes without errors, user prompts are understandable, minimum use of symbols or spacing in output. Some testing has been completed (20-34) | Does not execute due to syntax errors, runtime errors, user prompts are misleading or non-existent. No testing has been completed (0-19) |  |
| 2. Teamwork (b) | 1 | 3 | Group Performance | 5 | Actively engages and cooperates with other group member(s) in effective manner (4-5) | Cooperates with other group member(s) in a reasonable manner but conduct can be improved (2-3) | Distracts or discourages other group members from conducting the experiment (0-1) |  |
| 3. Conducting experiment (a, c) | 1 | 1 | On Spot Changes | 10 | Able to make changes (8-10) | Partially able to make changes (5-7) | Unable to make changes (0-4) |  |
| 1 | 1 | Viva/Quiz | 10 | Answered all questions (8-10) | Few incorrect answers (5-7) | Unable to answer all questions (0-4) |  |
| 4. Laboratory safety and disciplinary rules (a) | 1 | 3 | Code commenting | 5 | Comments are added and does help the reader to understand the code (4-5) | Comments are added and does not help the reader to understand the code (2-3) | Comments are not added (0-1) |  |
| 5. Data collection (c) | 1 | 3 | Code Structure | 5 | Excellent use of white space, creatively organized work, excellent use of variables and constants, correct identifiers for constants, No line-wrap (4-5) | Includes name, and assignment, white space makes the program fairly easy to read. Title, organized work, good use of variables (2-3) | Poor use of white space (indentation, blank lines) making code hard to read, disorganized and messy (0-1) |  |
| 6. Data analysis (a, c) | 1 | 4 | Algorithm | 20 | Solution is efficient, easy to understand, and maintain (15-20) | A logical solution that is easy to follow but it is not the most efficient (6-14) | A difficult and inefficient solution (0-5) |  |
| 7. Computer use (c) | 1 | 2 | Documentation & GitHub Submissions | 5 | Timely (4-5) | Late (2-3) | Not done (0-1) |  |
|  | Max Marks (total): | | | 100 | Obtained Marks (total): | | |  |

Lab Engineer Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_