Question 1.1 [25 marks]

Given a C++ program named **program1b.cpp** that contains two classes, `Undergraduate` and `Postgraduate`. In the main function of the program, two objects are created to test each of the classes. When the program runs, it prints out the output as shown in Figure 1. However, there is an issue with the program in terms of the implementation of the classes.

```
UNDERGRADUATE STUDENT INFORMATION:
Name       : Razali Hamzah
Matric     : A22CS1234
Faculty    : Faculty of Engineering
Program    : Bachelor of Computer Science
CGPA       : 3.8


POSTGRADUATE STUDENT INFORMATION:
Name       : Siti Nurhazila
Matric     : PCS20124
Faculty    : Faculty of Education
Program    : Master of Education Engineering
Project    : Futuristic T&L in Metaverse
Supervisor : Prof. Dr. Kamarul
```

Figure 1

a. Identify ONE (1) issue about the implementation of the classes. Justify your answer. (5 marks)

b. Rewrite the program to fix the issue using the concept of inheritance. (15 marks)

c. If you fix the issue using the concept of composition, what would the class diagram look like? Draw the diagram. (5 marks)

Note: *As for question (a), (b) and (d), write your answers in the docx file provided. Alternatively, you may also write answers on papers and take snapshots of them with your smartphone. As for question (c), modify the same program, program1b.cpp.*

Question 1.2 [25 marks]

Given a C++ program named **program1b.cpp** that contains two classes, `Undergraduate` and `Postgraduate`. In the main function of the program, two objects are created to test each of the classes. When the program runs, it prints out the output as shown in Figure 1. However, there is an issue with the program in terms of the implementation of the classes.

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Figure 1

a. Identify ONE (1) issue about the implementation of the classes. Justify your answer. (5 marks)

b. Rewrite the program to fix the issue using the concept of composition. (15 marks)

c. If you fix the issue using the concept of inheritance, what would the class diagram look like? Draw the diagram. (5 marks)

Note: *As for question (a), (b) and (d), write your answers in the docx file provided. Alternatively, you may also write answers on papers and take snapshots of them with your smartphone. As for question (c), modify the same program, program1b.cpp.*

Question 2.1 [35 marks]

Given a C++ program named **program2b.cpp** that four classes named `Course`, `Instructor`, `TextBook` and `Name`, respectively. Analyze the program and answer the following questions:

a. Draw the UML class diagram based on the implementation of all the classes in **program2b.cpp**. (10 marks)

b. Define a C++ template for a class named `Array` to store an array of object items in the same program **program2b.cpp**. The detail specifications of the class are as follows:
   i. Store the items in a `vector`.
   ii. Define a method named `add()` to add a new item (passed as a parameter) to the array.
   iii. Define a method named `getItem()` that returns an item based on the index passed as parameter to the method.
   iv. Define a method named `print()` to print all the items of the array.

(15 marks)

c. Test the template in the main function of **program2b.cpp** by accomplishing the following tasks. See expected output in Figure 2
   i. Create an array of instructors using the template and print all the items of the array.
   ii. Create an array of textbooks using the template and print all the items of the array.
   iii. Create a `Course` object with the following data and print the object.
   Title: **"Programming Technique II"**
   Instructor: the first item of the instructor array, created in f(i).
   Textbook: the second item of the textbook array, created in f(ii).

(10 marks)

Note: *As for question (a) draw your answers in the docx file provided. Alternatively, you may also write the answers on papers and take snapshots of them with your smartphone. As for questions (b) and (c), modify the same program, program2b.cpp.*

```
LIST OF INSTRUCTORS:

First name: Ahmad
Last name: Kamal
Office number: N28-L305

First name: Mellisa
Last name: Wong
Office number: D06-105

First name: Ali
Last name: Hassan
Office number: N28A-L501

------------------------------------------------------------
LIST OF TEXTBOOKS:

Title: Object-Oriented Programming Approach Using C++
Author: Gilberg
Publisher: Springer Publication

Title: Introduction to Functional Programming with TypeScript
Author: Samantha
Publisher: Oxford Press

------------------------------------------------------------
COURSE INFORMATION:

Course name: Programming Technique II
Instructor Information:
First name: Mellisa
Last name: Wong
Office number: D06-105

Textbook Information:
Title: Object-Oriented Programming Approach Using C++
Author: Gilberg
Publisher: Springer Publication
```

Figure 2

Question 2.2 [35 marks]

Given a C++ program named **program2b.cpp** that four classes named `Course`, `Instructor`, `TextBook` and `Name`, respectively. Analyze the program and answer the following questions:

a. Draw the UML class diagram based on the implementation of all the classes in **program2b.cpp**. (10 marks)

b. Define a C++ template for a class named `List` to store an array of object items in the same program **program2b.cpp**. The detail specifications of the class are as follows:
   i. Store the items in a `vector`.
   ii. Define a method named `get()` that returns an item based on the index passed as parameter to the method.
   iii. Define a method named `put()` that adds a new item (passed as a parameter) to the list.
   iv. Define a method named `print()` that prints all the items of the list.

(15 marks)

c. Test the template in the main function of **program2b.cpp** by accomplishing the following tasks. See expected output in Figure 2
   i. Create two objects of `TextBook` and two objects of `Course`. Assign each textbook to each course.
   ii. Create a list of courses using the class template. Use the course objects created in f(i) to fill in the list.
   iii. Create an `Instructor` object with the following data and print the object.
   Name: **"Ahmad Kamal"**
   Office : **"N28-L305"**
   Course: the first course from the list created in f(i).

(10 marks)

Note: *As for question (a) draw your answers in the docx file provided. Alternatively, you may also write the answers on papers and take snapshots of them with your smartphone. As for questions (b) and (c), modify the same program, program2b.cpp.*

```
LIST OF COURSES:

Course name: Programming Technique II

Textbook Information:
Title: Object-Oriented Programming Approach Using C++
Author: Gilberg
Publisher: Springer Publication
Course name: Functional Programming Fundamentals

Textbook Information:
Title: Functional Programming with TypeScript
Author: Samantha
Publisher: Oxford Press
-----------------------------------------------------

INSTRUCTOR INFORMATION:

Name: Ahmad Kamal
Office number: N28-L305
Course Information:
Course name: Programming Technique II

Textbook Information:
Title: Object-Oriented Programming Approach Using C++
Author: Gilberg
Publisher: Springer Publication
```

Figure 2

Question 3 [40 marks]

Given **program3b.cpp** that will ask the user to choose a three-dimensional object either cuboid or sphere, then to enter the size information about the object accordingly, and finally print out the volume of the object. However, if the user enters other inputs, the program will show an error message "`Invalid input`". Figure 3 shows some example runs of the program. Note that the bold texts indicate user inputs.

Run 1

```
Enter the type of object 1: Cuboid, 2: Sphere => 1
Enter the cuboid's dimensions, width, length and height => 2 3 4

Cuboid dimensions: 2 x 3 x 4
Volume: 24
```

Run 2

```
Enter the type of object 1: Cuboid, 2: Sphere => 2
Enter the radius => 4.5

Sphere's radius: 4.5
Volume: 381.51
```

Run 3

```
Enter the type of object 1: Cuboid, 2: Sphere => 5

Invalid input
```

Figure 3: Example results of the program

Rewrite the program using the concept of polymorphism and handling the user input error with exceptions. The new program should produce the same result as the original program. You are expected to add two additional classes to your program. You may use the inline style to define all the classes. Below are the expected elements that your program should include:

a. Definition of the class `ThreeDimensionalObject`. (7 marks)
b. Definition of the class that represents cuboid objects. (10 marks)
c. Definition of the class that represents sphere objects. (10 marks)
d. Definition for the main function. (9 marks)
e. Handling the user input error using an exception approach (4 marks)

Note: *As for all questions (a) to (e), rewrite the same codebase program,* ***program3b.cpp****.*