

FINAL EXAMINATION

Course: **OBJECT ORIENTED PROGRAMMING**

Time: **100 minutes**

Term: **3 – Academic year: 2018-2019**

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Student name:

Student ID:

(Notes: Closed book exam)

- Question 1.** a) Describe the difference between **private**, **public**, and **protected** in controlling the accessibility of object members in C++.
- b) What is destructor in C++? When and why do we need to explicitly define the destructor for a class?
- c) What is the difference between **overloading** and **overriding**?
- d) Reuse what is already written is one of the main purposes of OOP, why it is easier to reuse in C++ than in C?

Question 2. Assume all necessary libraries are included, read the C++ code below and answer the following questions:

```
01: class Chef {
02: public:
03:     virtual void prepare() = 0;
04:     void makeDish() {
05:         prepare();
06:         cout << "Made by Chef\n";
07:     }
08: };
09: class HeadChef: public Chef {
10: public:
11:     virtual void prepare() {
12:         cout << "Prepared by HeadChef\n";
13:     }
14: };
15: class SecondChef : public HeadChef {
16: public:
17:     void prepare() {
18:         HeadChef::prepare();
19:         cout << "Added by SecondChef\n";
20:     }
21: };
```

```

22: void makeFood(HeadChef c1, SecondChef c2) {
23:     c1.makeDish();
24:     c2.makeDish();
25: }

26: void main() {
27:     SecondChef c;
28:     makeFood(c, c);
29:
30:     Chef *c1;
31:     c1 = new Chef;
32:     c1->prepare();
33:
34:     c1 = new HeadChef;
35:     c1->prepare();
36:
37:     c1 = new SecondChef;
38:     c1->prepare();
39:
40:     SecondChef *c2 = new HeadChef;
41:     c2->prepare();
42: }

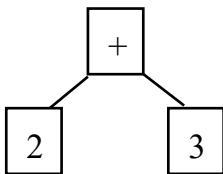
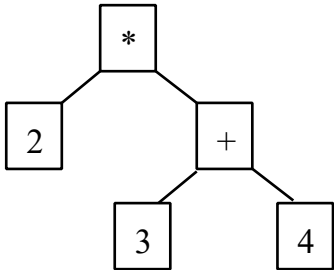
```

- Are there any lines in the main() function that cannot be compiled? Why can't they be compiled?
- Assume that all invalid lines of code are removed, what is printed to the screen after the line 28 is run?
- Assume that all invalid lines of code are removed, what is printed to the screen after the line 42 is run?
- At line 28, 'makeFood' takes two SecondChef objects as arguments, explain why it can do that.

Question 3. Consider a basic mathematical expression which is a series of real numbers and arithmetic operations (+, -, *, /). A design option to represent this kind of expression is by using a tree.

There are two types of nodes in the expression tree:

- Number node: represents a number which has numerical value.
- Operation node: represents an operation which contains an operation symbol. Each symbol is either +, -, *, or /. Each operation node contains a left and a right node, which can either be number node or operation node.

Expression	Tree representation	Sample usage code
2 + 3	 <pre> graph TD A["+"] --- B["2"] A --- C["3"] </pre>	<pre> OpNode n('+'); n.addLeft(new NumNode(2)); n.addRight(new NumNode(3)); double x = n.evaluate(); // x = 5 </pre>
2 * (3 + 4)	 <pre> graph TD A["*"] --- B["2"] A --- C["+"] C --- D["3"] C --- E["4"] </pre>	<pre> OpNode n1('+'); n1.addLeft(new NumNode(3)); n1.addRight(new NumNode(4)); OpNode n2('*'); n2.addLeft(new NumNode(2)); n2.addRight(&n1); double x = n2.evaluate(); // x = 14 </pre>

Applying encapsulation, inheritance and polymorphism in object oriented programming, you are asked to do the following:

- Draw a class diagram to show the tree representation above.
The design should include necessary functions to construct an expression tree and evaluate the value of the expression.
- Write C++ code to implement the design.

*** GOOD LUCK ***