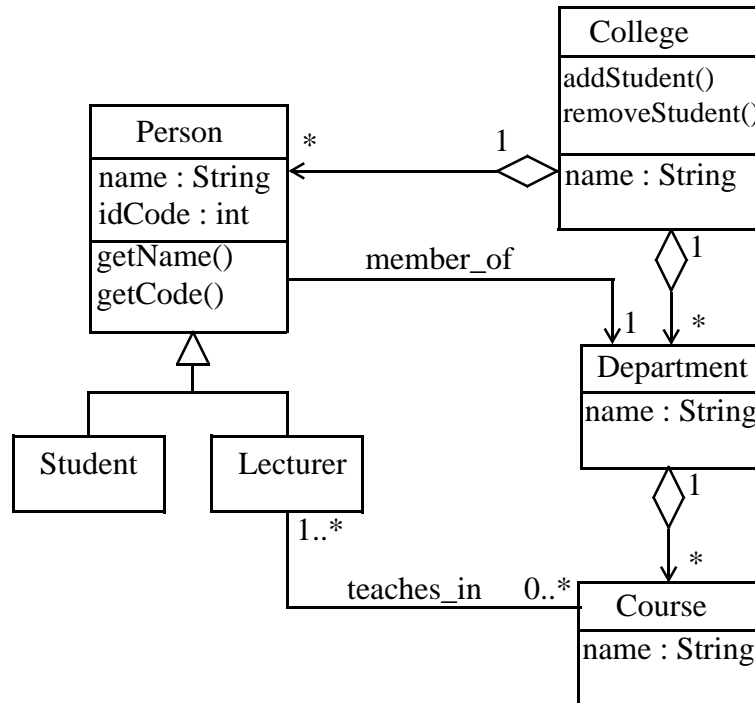# 1B11 Exam 2000
3 Hours

Answer ALL questions from Part I and THREE questions from Part II

Part I

1.   Consider the UML class diagram below:

a) Write Java versions of the all the classes in the diagram, implementing only the variables, methods and relationships shown. Include a suitable constructor in each class.

(The Java code does not have to be syntactically perfect but should, at least, demonstrate how to correctly write the classes and methods.)

[20 marks]

b) Briefly describe how your classes should be tested.

[5 marks]

c) To explore the development of a complete program based on the classes in the diagram a prototyping approach might be followed. Outline how prototyping is performed, highlighting any advantages or disadvantages in using it.

[5 marks]

[Total 30 marks]

2. Explain each of the following:

   type, shallow copy, cast expression, scope, encapsulation

   [Total 7 marks]

3. a) Draw a syntax diagram for the *compound statement*. Add lookahead(s) as necessary. Show how your syntax diagram may be implemented as a method in a recursive-descent parser.

   Explain the relationship between *statement* and *compound statement*.

   [4 marks]

   b) The following are simple examples of the *declaration statement*:

   ```
   char ch ;
   int x ;
   char a = 'a', b = 'b' ;
   int m = 5, n ;
   ```

   Char and int variables may be declared. Several variables of the same type may be defined in one declaration. Variables may be assigned constant values.

   Draw syntax diagram(s) to define char and int *declaration statements* such as these.

   [4 marks]

   [Total 8 marks]

   END OF PART I

Part II
Answer THREE questions

4. a) Method parameters are passed by value — explain what this means.

[2 marks]

b) How is an object passed as a parameter to a method?

[2 marks]

c) What are the differences between instance methods and static methods?

[4 marks]

d) Write a method that takes two parameters, an array of integers and a single integer, and returns an array containing all the values in the parameter array that are exactly divisible (i.e., leave a remainder of zero) by the second integer parameter. The array returned should not have any unused elements.

[10 marks]

[Total 18 marks]

5. a) What is an abstract class and what role do abstract classes play?

[3 marks]

b) What is dynamic binding? Illustrate your answer with an example.

[6 marks]

c) Consider the following statement:

    B b = new B(2) ;

if class B is a subclass of class A, explain step-by-step what happens when the statement is executed, assuming that A has one constructor that takes an integer argument.

[9 marks]

[Total 18 marks]

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6. a) Outline the implementation of a double-linked list class in Java, including an iterator. What role do object references play in your implementation?

    [10 marks]

    b) What are the advantages and disadvantages of a double-linked list data structure in comparison with an array? Include a table showing the performance properties of arrays and double-linked lists when fetching at the start, fetching in the middle, fetching at the end, inserting in the middle, inserting at the end, deleting in the middle, deleting at the end and searching for a value.

    [8 marks]

    [Total 18 marks]

7. a) Explain the following terms:
    i) *recursive-descent compiler*
    ii) *lexeme*
    iii) *token* (giving an example of a keyword, an identifier, an integer constant, and an operator)
    iv) *matching* (and explain what a *matcher* does)

    [6 marks]

    b) Draw syntax diagrams for:
    i) the *while statement*
    ii) the *conditional statement* (if with optional else)

    [4 marks]

    c) Suppose that an existing syntax diagram for *expression* (which you are **not** asked to reproduce) defines expressions involving the relational operators but does not cover the boolean operators || (or) and && (and).
    Show how by modifying the syntax diagram for *expression* and introducing new syntax diagrams these boolean operators may be incorporated with their Java priorities.

    [8 marks]

    [Total 18 marks]

8. Consider the following recursive method:

```java
public static int f(final int n)
{
    if (n < 1)
    {
        return 1 ;
    }
    else
    {
        return f(n-1) + f(n-1) ;
    }
}
```

a) What values do the method calls f(0), f(1), f(2), f(3), f(4) and f(5) return?

[4 marks]

b) What mathematical function does the method implement?

[2 marks]

c) What is the meaning of the keyword final as seen in the method above? Does removing the keyword make any difference to the execution of the method?

[2 marks]

d) Re-write the method to use iteration instead of recursion. Which version will evaluate the call f(20) quickest?

[6 marks]

e) What are the advantages and disadvantages of using recursion?

[4 marks]

[Total 18 marks]

END OF PAPER