1B11 Exam 2001
3 Hours

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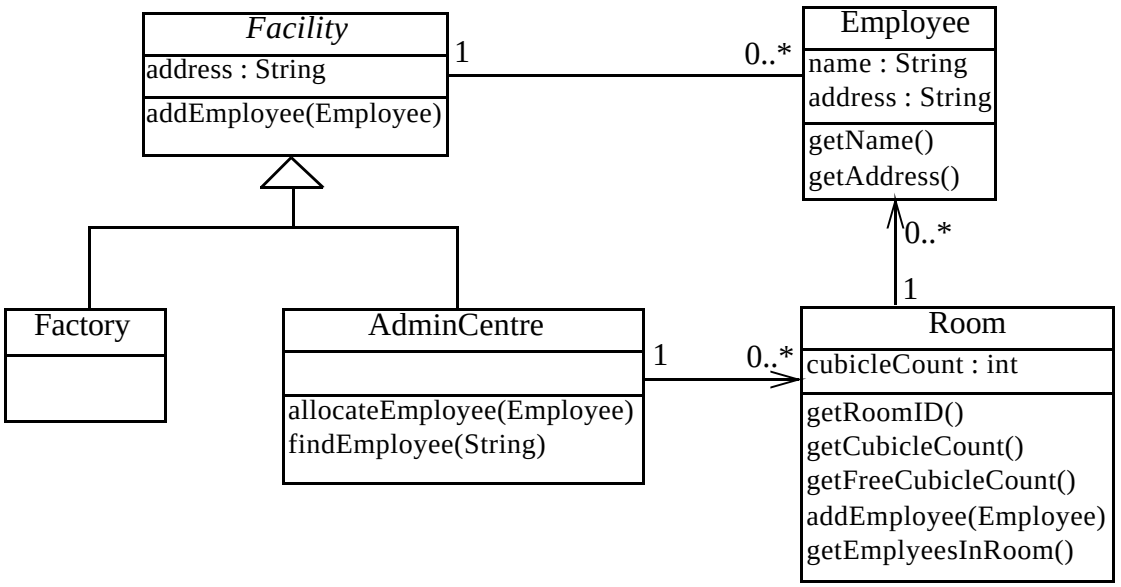
Answer ALL questions from Part I and THREE questions from Part II

Part I

1. Consider the UML class diagram below:



a) Write a Java version of class Employee, assuming it has a constructor method with this signature:

```
public Employee(String name, String address, Facility facility)
```

[4 marks]

b) A room holds a number of cubicles (work areas), each of which can be allocated to one employee. An employee can be added to a room if there is a free cubicle available. Write a Java version of class Room, assuming it has a constructor method with this signature:

```
public Room(int cubicleCount)
```

[6 marks]

c) Class Facility is an abstract class. Explain what this means.

[3 marks]

d) Write a Java version of class Facility, assuming it has a constructor with the signature:

```
public Facility(String address)
```

[5 marks]

[Question 1 cont. over page]

[Question 1 cont.]

e) Write a Java Version of class AdminCentre, assuming it has a constructor with the signature:

```
public AdminCentre(String address, Room[] rooms)
```

and these methods:

```
// Allocate an employee to a room with an available cubicle.
// Return false if no cubicle is available, otherwise true.
public boolean allocateEmployee(Employee e)

// Return the room containing the named employee,
// or null if no employee is found.
public Room findEmployee(String name)
```

[7 marks]

f) Explain step-by-step what happens when an AdminCentre object is created using the new keyword.

[5 marks]

[Total 30 marks]

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

2. Explain each of the following:
abstraction, lifetime, static method, overloading, expression

[Total 7 marks]

CONTINUED

3. a) Using the following piece of code as an example

```
while (count <= 1000)
{
   count = count + 100;
}
```

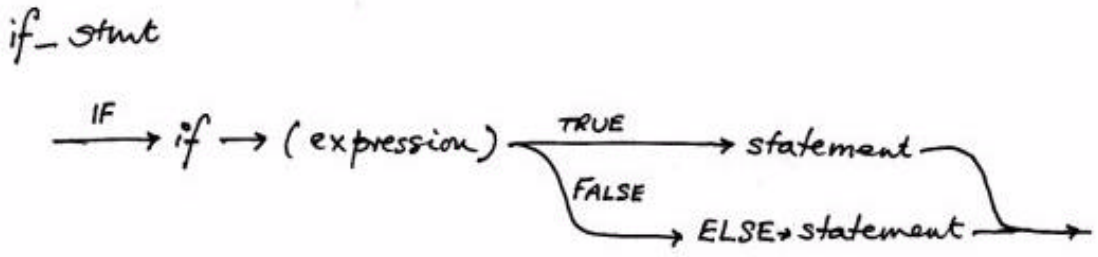
explain the terms lexeme, keyword, token, token type, token value, literal.

[2 marks]

b) Draw a syntax diagram for a compound statement. Add lookaheads to direct parsing.

[2 marks]

c) The syntax diagram below is taken from some student work.



Give a critical appraisal of the diagram. You may wish to comment on issues such as whether it correctly models a construct in Java, whether the lookaheads are appropriate, whether the diagram is consistent in its notation, and what misconceptions it shows.

[4 marks]

[Total 8 marks]

Part II
Answer THREE questions

4. a) An array is represented by an object. Explain the consequences of this, including an explanation of how arrays are passed as method parameters.

[4 marks]

b) Write down the Java statements needed to declare and create a 10x10x10 array of Strings, with each string initialised to “hello”.

[4 marks]

c) List the advantages and disadvantages of using a container class such as ArrayList in place of an array.

[4 marks]

d) Outline how class ArrayList could be implemented using an array.

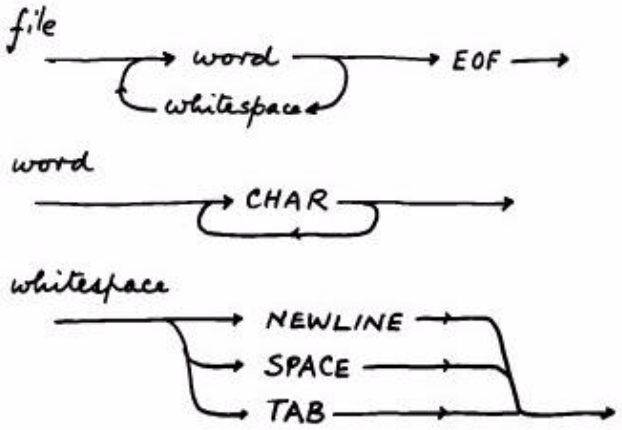
[6 marks]

[Total 18 marks]

CONTINUED

5. a) The Unix command wc counts and prints the number of lines, words, and characters in a file. It can process any kind of file, of arbitrary content. The line count is simply a count of the number of newline characters in the file. A word is defined to be a maximal string of characters delimited by whitespace. Whitespace consists of the characters space, newline, and tab (vertical tab and form feed may be ignored here). All characters are included in the character count.

The following syntax diagrams are a first (and poor) attempt at a definition of a file for processing by wc:



In the syntax diagrams the token CHAR represents any character except whitespace characters. EOF is a token representing end-of-file.

The syntax diagrams given define only a subset of the files that wc would process.

i. Identify and state the limitations of the given definitions.
ii. Draw syntax diagrams that define file fully.
iii. Add lookaheads to your syntax diagrams to aid parsing.
iv. Annotate (with lassos and actions) your syntax diagrams to form the basis of an implementation of wc.
v. Show how your syntax diagrams could be implemented as Java methods.

[Total 18 marks]

6. a) The following are examples of defensive programming techniques:
   i) Don’t use public instance variables.
   ii) Always use a compound statement for if and loop statement bodies.
   iii) Properly indent source code.
   iv) Always initialise variables.
   For each example, explain why it is good advice.

   [6 marks]

   b) “Testing must be repeatable.” Explain this statement.

   [2 marks]

   c) Outline the implementation of a test harness class to test the ArrayList class.

   [10 marks]

   [Total 18 marks]

7. a) Describe the key properties of a binary tree.

   [3 marks]

   b) Write a Java class to represent a binary tree node.

   [3 marks]

   c) Outline the implementation of a Java BinaryTree class using the node class. Include methods for inserting values, searching for values and deleting values (pseudocode can be used).

   [10 marks]

   d) Briefly compare the performance properties of a binary tree to a linked list.

   [2 marks]

   [Total 18 marks]

8. a) Write an iterative method with this signature:

```
public int count(String s, char p)
```

that returns the number of times the character p occurs in the String s.

[4 marks]

b) Write a recursive version of the count method.

[6 marks]

c) Write a method that calls the count method to determine the number of times each of the letters a-z occur in a String, and returns an array of 26 integers holding the counts.

[5 marks]

d) "The method from part c) should not use the recursive version of the count method." Comment on this statement.

[3 marks]

(The Java code given for parts a, b and c does not have to be syntactically perfect but should, at least, demonstrate how to correctly write the methods.)

[Total 18 marks]

END OF PAPER