UNIVERSITY OF LONDON

291 0226 ZB

B.Sc. Examination 2008

COMPUTING AND INFORMATION SYSTEMS

CIS226   Software Engineering, Algorithm Design and Analysis (Eastern)

Duration: 3 hours

Date and time Wednesday 14 May 2008 : 10.00 – 1.00 pm

Full marks will be awarded for complete answers to a total of FOUR questions.

You must answer TWO questions from Section A and TWO questions from Section B.

Each question carries 25 marks. The marks for each part of a question are indicated at the end of the part in [.] brackets.

There are 100 marks available on this paper.

No calculators should be used.

THIS PAPER MUST NOT BE REMOVED FROM THE EXAMINATION ROOM

Section A

Question 1

(a) Explain what *software testing* means in no more than two sentences.　　　[2 marks]

(b) Explain what *software validation* means in no more than two sentences.　　[2 marks]

(c) Given two modules of a software system, *A* and *B*, how should they be related in terms of *coupling* and *cohesion* in order for the overall system to be well designed and why?

[6 marks]

(d) How could you capture in a use case diagram the fact that a certain use case can also have a different outcome from its normal success scenario.　　　[2 marks]

(e) Which are the two main characteristics of an *interface*.　　　[2 marks]

(f) Outline in not more than four sentences the main role of an *interface*.　　[2 marks]

(g) What is the UML notation for *ClassA can send messages to ClassB*?　　[2 marks]

(h) What is it meant by *ClassA implements InterfaceA*?　　　[2 marks]

(i) With reference to messages, attributes and operations (methods), state in which circumstances *class A depends on class B*?　　　[3 marks]

(j) Define the term *instantiation*. Can an *interface* be *instantiated*?　　[2 marks]

Question 2

(a) Draw a use case diagram for the following specification of a drawing tool. *Among other features, the tool should allow users to move (translate) already drawn shapes and also to fill them with a chosen colour. In each case, the target shape would have to be selected first. When a shape is attempted to be moved but the cursor goes outside the drawing area, the operation is cancelled and the shape is left in its original place.*

[5 marks]

(b) Represent the following specification for a library catalogue as a UML class diagram. *The library has publications. They can be of two types, books and journals. Users of the library can borrow both books and journals. The maximum limit for books is 4 and for journals is 8.*

[6 marks]

(c) Consider the following class diagram.
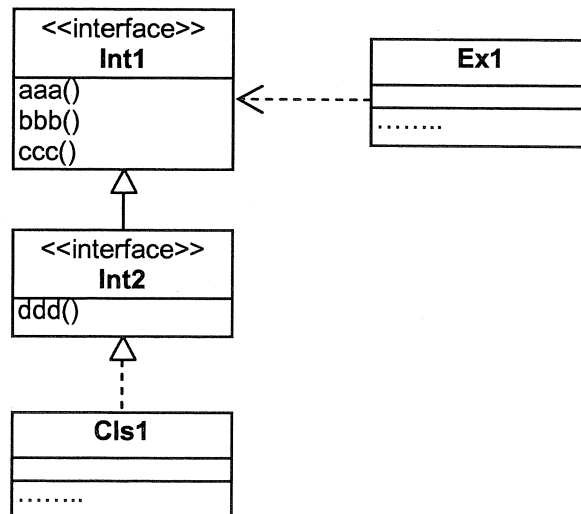
(i) What is the relationship between *Cls1* and the interfaces *Int2* and *Int1*?

[2 marks]

(ii) Which parts of code (i.e. corresponding to which diagram components) should or might be required to be modified, if a modification is made to the code representing interface *Int2*, and which are safe to remain unchanged? Explain your answer.

[4 marks]

(d) Represent the following specification for a drawing tool as a UML class diagram. *The tool supports the drawing of circles and polygons. A circle must have a point as its centre. A polygon has three or more points as its vertices. If any of the points defining one of these two types of shapes is removed, then the whole shape loses its meaning. A point can have one label associated with it, but this is optional.*

[8 marks]

Question 3

(a) Consider the following sequence diagram.
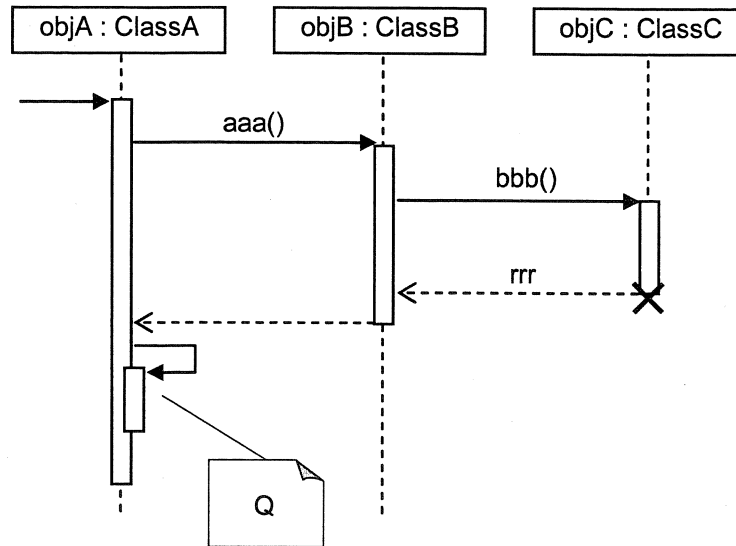
Answer the following questions.

(i) What does the arrow labelled aaa() represent? [1 mark]

(ii) What must the definition of ClassB include in order for the notation mentioned above to be correct? [1 mark]

(iii) What is the notation for representing an *active* object? [1 mark]

(iv) Which happens first *aaa()* or *bbb()*? [1 mark]

(v) What does the element labelled *rrr* represent? [1 mark]

(vi) What does the cross (X) represent (under *objC*)? [2 marks]

(vii) What does the element commented with Q represent? If it is removed, does the diagram preserve the meaning? [2 marks]

(b) Consider the following specification.

A students monitoring software program of a university can calculate the classification degree for all the students who completed their programmes. This is realised via a degree calculator tool, which is implemented as an object. Students, represented as objects, are organised on departments, which, too, are represented as objects. The process of calculating the degree is as follows: the tool is invoked from the interface by a user, with a certain department for which the calculation is to be made; the department finds all its students who completed the programme; it returns them to the tool which then addresses them, each with the formula corresponding to their programme.

Consider that the chosen department has only two students, of which only one has their programme completed. Draw a sequence diagram which describes the process of calculating the classification. **Hint.** There are four objects in this scenario: a calculator, a department, and two students. The calculator is live activated with a *start()* message from the user. The first message sent by the calculator is to the department, to enquire which students have completed. Then the department asks the students in turn. The calculator has to send the appropriate formula to the student who completed the degree such that s/he would know how to calculate their degree (you can model this as a synchronous process). [16 marks]

Section B

Question 4

(a) Explain, with an example, what a quadtree is. Define a Java class `quadtreeNode` for quadtrees. Assume there is only one integer label for each node. [10]

(b) Explain, with an example, how to distinguish a *binary search tree* and a *binary tree*. Draw both types of trees for (5, 7, 10, 6, 1, 14, 11) in your example. [5]

(c) Draw a minimum weight spanning tree of the simple graph below. Explain why such a tree is not necessarily binary. Draw two rooted trees to demonstrate your conclusion. [5]
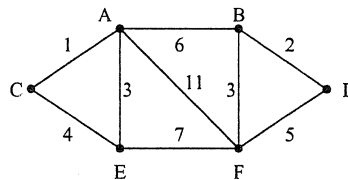
(d) What is a "greedy approach"? Describe, with an example, a computational problem which can be solved by a greedy approach. [5]

Question 5

(a) Explain, with an example, why every node of a linked list should be an *object* type containing at least two different types of fields in implementations. [5]

(b) Consider a so-called *set partition* problem described below. [15]

> Given n positive integers, partition them into two *disjoint* subsets with the same sum of their elements. Minimise the number of the subsets tested in your algorithm.

   (i) Write two different instances of the problem including one *special case*. *Hint: A special case can be that there is no solution or that requires an unusual solution. Add assumptions if necessary.*

   (ii) Choose a data structure for solving the problem.

   (iii) Design and outline an exhaustive-search algorithm for this problem.

   (iv) Analyse the time complexity of your algorithm for the worst case.

(c) Explain, with an example, what is meant by *double hashing*. [5]

Question 6

(a) Consider the task of maintaining a million-record list of supermarket customers.

    (i) Propose a suitable data structure for the task. Justify your choice and add assumptions if necessary. [3]

    (ii) Discuss the suitability of using two standard methods *size* and *isEmpty* in terms of efficiency. [4]

    (iii) Suppose that we need to keep track of the total number of the customers. How would you implement the two methods? [3]

(b) Write a method `equal(G1, G2)` for comparing the contents of two graphs. It should return `true` if both graphs contain identical values. Explain how your algorithm works by giving a small example. [10]

(c) The terms *abstract data structure* and *abstract data type* are often used interchangeably. Explain briefly, with an example of their use, when *abstract data structure* is more appropriate and when *abstract data type* is more appropriate. [5]