UNIVERSITY OF EDINBURGH

FACULTY OF SCIENCE AND ENGINEERING

MASTER OF SCIENCE IN COMPUTER SCIENCE

SOFTWARE ENGINEERING WITH OBJECTS AND COMPONENTS 2

Friday 28 April 2000

9:30 to 11:00

Examiners:

I. Watson (External)

R.N. Ibbett (Chairman)

INSTRUCTIONS TO CANDIDATES

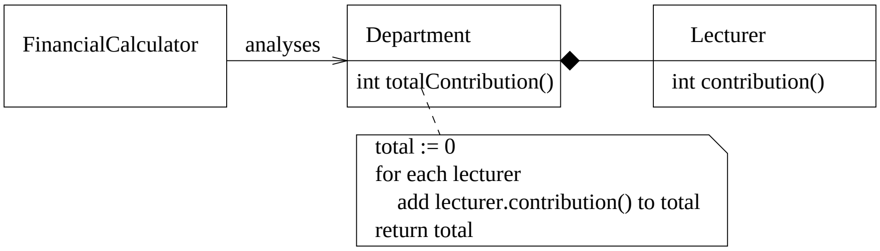
Answer any TWO questions.

All questions carry equal weight.

1. (a) Briefly explain what is meant in software engineering by the terms *pattern* and *refactoring*. [*6 marks*]

(b) What are the benefits of using refactoring? [*3 marks*]

(c) A university financial package (FP) calculates the "total contribution" for a given Department by adding up the contributions of the lecturers in the department. Each lecturer is in exactly one department. The following UML diagram, which is an extract from the full class diagram of the system, illustrates this:



The University wishes to alter the design of the FP system to reflect the university's new more flexible structure, in which some lecturers are members of sub-departmental administrative units called Institutes. Thus, a Department may contain some Institutes, and perhaps also some lecturers who aren't in any Institute. The University wishes the system to allow for the possibility that Institutes could themselves be made up of smaller groups, and so on.

- What design pattern would you use in the redesigned FP system to give this flexibility?
- Draw a revised version of the diagram above to illustrate your solution.
- What changes must be made to the FinancialCalculator class, assuming that in the original system it is not dependent on the Lecturer class? [*8 marks*]

[**Note:** You need not consider any functionality beyond what is shown in the diagram above; in particular, you need not consider how objects are created and deleted.]

(d) How would you introduce the design change? Describe a suitable sequence of between 3 and 6 steps. Your description should make clear which classes or methods are added or deleted in each step. You should also make clear in which step(s) the changes to FinancialCalculator, which you described above, are made, and why you have chosen to make them at that stage.

[**Note:** You need not, however, describe the steps in detail, and you need not discuss changes to the associated tests. You may find it helpful to draw further diagrams, but full marks can be obtained by a clear description using words alone.] [*5 marks*]

QUESTION CONTINUES ON NEXT PAGE

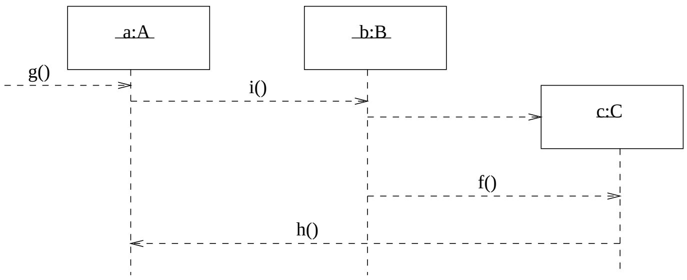
(e) You now discover that some lecturers wish to belong to several Institutes simultaneously. What minimal change to your diagram would permit this? Briefly assess any problem that this might cause, and outline a solution. (You need not describe your solution in detail; in particular, you are not expected to draw another diagram.) [*3 marks*]

2. (a) Explain, using a sentence for each, three advantages that can be gained by the automation of software testing. [*6 marks*]

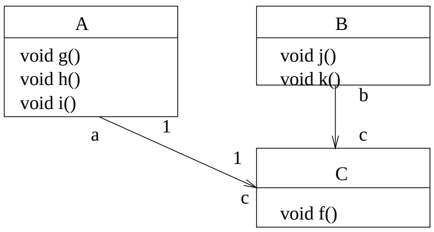
(b) Briefly describe the relevance of software test automation to quality *assurance*. You should mention both CMM and ISO9001. [*5 marks*]

(c) A designer has drawn the UML diagrams below to represent the design of a system. Identify any UML errors, and any inconsistencies which would make it impossible to implement the system as designed. You need not suggest how to fix these problems. [*5 marks*]

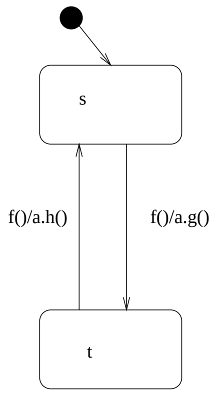
[**Note:** You may assume that the designer intends to follow all conventions used in this course; in particular, that the designer uses a dynamic notion of association. Names in the diagrams have been made deliberately meaningless to emphasise that you are only required to analyse the system on a technical level.]



Sequence diagram



Class diagram



State diagram for class C

QUESTION CONTINUES ON NEXT PAGE

(d) More generally, suppose that you have state diagrams for the classes of all the objects which are involved in a given interaction. Explain how you would *systematically* check that a sequence diagram describing the interaction is consistent with the state diagrams. In the light of your explanation, can you suggest any extra information that a sequence diagram might usefully record about the objects which take part, apart from their classes? [*5 marks*]

[**Note:** You may assume that the state diagrams are complete in the sense that they record (in the events on their transitions) all messages which an object of the class may receive when in a given state, and (in the actions on their transitions) all messages which the object will send as a result. You may also assume that all diagrams are consistent with the class diagram of the system; this part of the question concerns only state and sequence diagrams.]

(e) To what extent, if at all, do you think it would be useful and feasible to carry out automated testing on UML models as well as on code? Briefly explain your opinion, with reference to the advantages of automated testing that you identified in part (a). [*4 marks*]

3. (a) What is meant by (a) version control and (b) software configuration management? *[6 marks]*

   (b) List 5 of the central practices of Extreme Programming. *[5 marks]*

   For the rest of this question, imagine that you are advising your client, Another Software Company Ltd (ASC), about how to improve its software development process. ASC's main product is a UML CASE tool which is available for several operating systems and in several versions (a limited version available free to students, a "small business" version, and a more sophisticated and expensive "professional" version.) It makes releases frequently to track the changing UML standard; most of its clients download new versions regularly from a password-protected web site.

   ASC has occasionally had problems with defects in its products being found just before release. It has twice released versions of its product which subsequently proved to be wrongly configured; on one occasion a vital library was missing from the distribution, and on another the installation script failed to run on certain hardware configurations.

   (c) It has been suggested that ASC should adopt the "Daily Build and Smoke Test". Give your views on how helpful this would be in solving ASC's quality problems. You should include a brief explanation of what "Daily Build and Smoke Test" is. You may wish to mention questions which should be answered before a decision is made. *[10 marks]*

   (d) What else would you advise ASC to consider doing to address its quality problems? *[4 marks]*