

THE BRITISH COMPUTER SOCIETY

THE BCS PROFESSIONAL EXAMINATION Diploma

OBJECT ORIENTED PROGRAMMING (Version 2: New Syllabus)

21st April 2004, 2.30 p.m.-4.30 p.m.

Answer FOUR questions out of SIX. All questions carry equal marks.

Time: TWO hours.

*The marks given in brackets are **indicative** of the weight given to each part of the question.*

1. A University's library stores various items that can be borrowed, including books and journals. Both staff and students can borrow books, but only staff members can borrow journals. Students can borrow up to a maximum of 5 books and staff can borrow up to a maximum of 10 books and 3 journals. Books can be borrowed for two weeks and journals one week. If the borrower keeps the book or journal longer than this, they are subjected to a fine, which is increased daily.

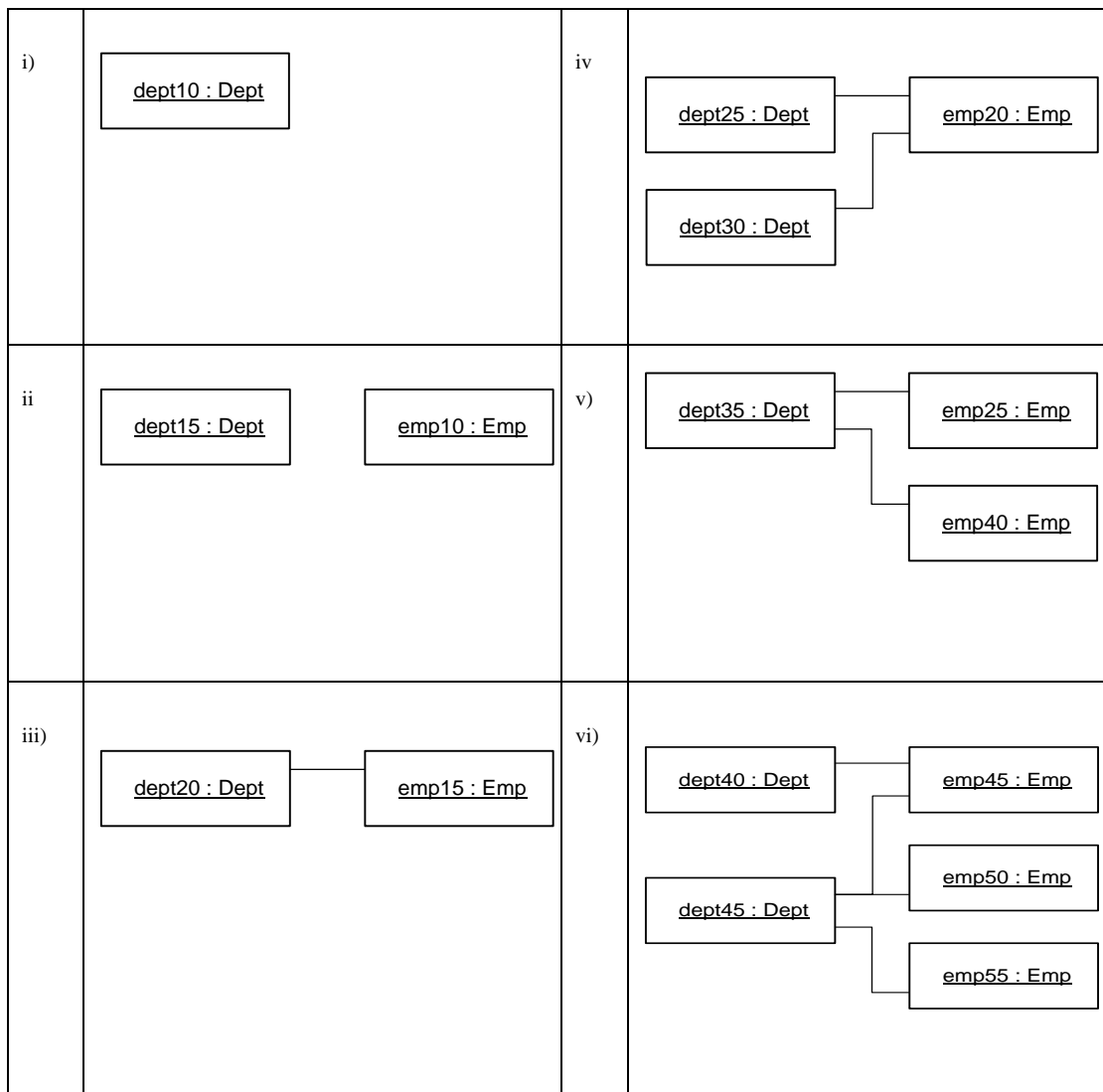
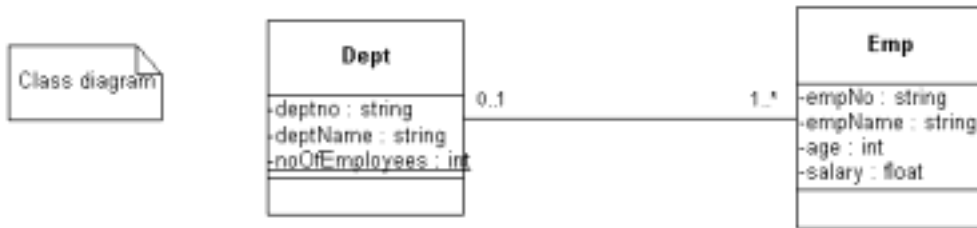
When a user borrows a book, they provide their *libraryId*, if this is valid their loan details are checked to ensure that they have not already borrowed above the maximum permitted number of books. They will not be allowed to borrow above the maximum number. A check is also made to see if they have any fines. If they have a fine, then they cannot borrow any items until the fine is paid. If all the checks are ok, then the item is issued to the user and the return date is assigned to the loan. At this point the user can optionally ask for a printout, which summarises all of the items they have on loan and when each item is due back.

Users can check their own loan details at any time. Librarians are permitted to check the loan details of any user.

Library users can reserve books that are currently out on loan. Journals cannot be reserved. If three reservations have already been made for a given book, and a further reservation is made, a new copy will be ordered by the librarian.

- a) Draw a use-case diagram for the library system. **(15 marks)**
- b) Write down a use-case description of the way a user borrows a book. Your answer should include the normal sequence and three alternative sequences such as when invalid data is provided. **(10 marks)**

2. a) Given the class diagram below, state which of the object diagrams (i-vi) are legitimate instances. Assume that all links in the object diagram are instances of the association shown in the class diagram. If an object diagram is not legitimate explain why not. **(10 marks)**



- b) In a programming language with which you are familiar, write code to implement the class diagram above. Within your code provide a default constructor for each class that sets strings to "Not known" and numeric fields to 0. Your code should also show how the association relationship is implemented in both classes. **(15 marks)**

3. a) Explain and show with an example, how a sequence diagram is used to describe the interactions between objects. Show also how the same interaction could be described by a corresponding collaboration diagram. Identify the significant differences between collaboration and sequence diagrams and their individual strengths. **(6 marks)**

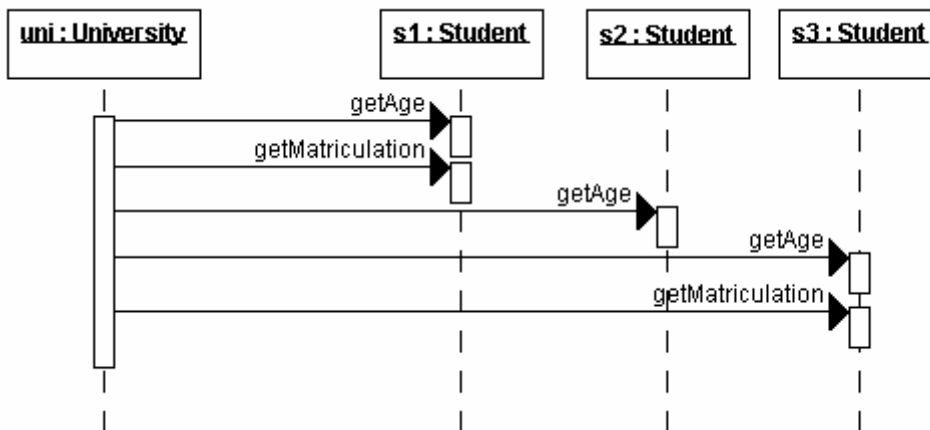
b) In the following class diagram, a Bank is shown with a one-to-many relation with the Account class. The method `getBalance` delivers the balance for an Account object, while the method `getTotalBalances` determines the sum of the balances for the Account objects associated with a Bank object.

Present a collaboration diagram for the realisation of the method `getTotalBalances`. **(4 marks)**



Show the same interaction presented as a sequence diagram. **(4 marks)**

c) In the following sequence diagram, a University object is shown sending the message `getAge` to each of its three Student objects, and for those that are over the age of 21, they are also sent the message to obtain their matriculation number. Present a class diagram showing its attributes and methods that models this scenario.



(8 marks)

d) A collaboration diagram that does not show any messages is known as an *object diagram*. Explain its purpose. **(3 marks)**

4. a) Carefully explain the occasions on which you would use the following:
- i) a constant instance variable (or field)
 - ii) a class variable (or field)
 - iii) a class method (or operation)
 - iv) a concrete class
 - v) an abstract class
- (10 marks)**

- b) A lending library holds a large number of publications that may be books or journals. Both are given a title e.g. “Object-Oriented Programming” and a unique reference number e.g. 123. The reference number is not expected to change. In addition each book also has an author e.g. “John Smith” and an international standard book number e.g. 0-13-12344567-8. Each journal also has a date of publication e.g. 15-12-2003 and the name of its editor. Finally all publications in the library need to hold the name of the library they are in e.g. “City Library”.

Using an object-oriented programming language of your choice, provide sample code that demonstrates the use of the five concepts in part a) above when implementing the lending library scenario. **(15 marks)**

5. a) Give brief definitions of the following:
- i) coupling
 - ii) cohesion
 - iii) information hiding
 - iv) abstraction
- (8 marks)**

- b) Explain how abstraction is facilitated by a typical object-oriented programming language. **(7 marks)**

- c) Discuss ways in which object-oriented techniques can influence the level of coupling and cohesion. **(10 marks)**

6. a) Explain what is meant by the term *delegation*. **(5 marks)**

- b) A small software company requires that its employees are flexible in the tasks that they are able to perform. For example, an employee may undertake an administrative role in the morning but be a programmer in the afternoon. However it should be possible to determine at any given time what an employee is doing. You are asked to develop software to display on a computer screen the role of each employee in the company at any given time.

- i) Explain why inheritance alone is not appropriate when modelling the company and its employees. **(5 marks)**

- ii) Give an initial class diagram for the company and its employees demonstrating the use of delegation. **(10 marks)**

- iii) Using an object-oriented language of your choice, outline how your design might be implemented. **(5 marks)**