Tuesday 27 January 2009
3.00 pm – 4.30 pm
(Duration: 2 hours)

DEGREES OF MSci, MEng, BEng, BSc, MA and MA (Social Sciences)

COMPUTING SCIENCE 3?:
PROFESSIONAL SOFTWARE DEVELOPMENT 3

(Answer all ? questions.)
(Answer ? out of ? questions)

This examination paper is worth a total of ?? marks

You must not leave the examination room within the first hour or the last half-hour of the examination. (for exams of 2 hours duration)

You must not leave the examination room within the first half hour or the last fifteen minutes of the examination. (for exams of less than 2 hours duration)

Section A

1. **(a)** What is meant by software engineering?

    Different types of problem can lead to the failure of large-scale software development projects. For example, *building a system for a bad reason* (e.g., following a political imperative or basing the project on thoughtless assumptions) can lead to project abandonment. Describe two other basic kinds of reason why a project might fail, other than the quality of the programming.

    [6]

    (b)

Task	Dependency	Duration
T1	-	2
T2	-	1
T3	T1	3
T4	T2	2
T5	T3,T4	4
T6	T3,T4	6
T7	T5	3
T8	T6	4

    Create a PERT chart to represent the activities described in the task dependency table above. Identify the critical path, if there is one, justifying your answer by suitable labelling of the PERT chart.

    Why would you choose to use a Gantt chart rather than a PERT chart during the management process?

    [6]

    (c) What is meant by risk? Identify and briefly describe the two key characteristics of risk.

    Briefly describe each of the following and explain how they can contribute to the reduction or mitigation of risk:

    - Spiral Model of Development

    - Quality Assurance

    [8]

2. (a) Describe the purpose of use case diagrams and activity diagrams during the elaboration phase of the Rational Unified Process.

[2]

The following scenario is used for parts (b) to (d) of this question.

Do-it-All-by-Yourself is a company that sells a range of construction tools (power drills, spades, wheel barrows etc.) and consumable supplies (paint, chipboard etc.). The company wishes to develop a computer system for managing sales to customers and stock levels in the warehouse.

A customer must be registered with the company before a sale can be made. Company sales-staff record the details of prospective sales to customers in an invoice, which consists of a number of lines. Each line specifies a product and a unit amount for the sale. Each product has a description, a unique product code, a unit price and a stock level (the number of units of the product currently in the warehouse). An invoice may be amended several times (e.g. due to changing stock levels) during preparation and may need to be printed for the customer.

Financial transactions of sales are recorded on a separate accounting system. When a sale is made, the corresponding invoice is marked as being complete, and no further changes can be made. The final version of the invoice is to be printed out as part of the sale receipt. The system adjusts recorded stock levels once a sale has been completed.

A stock check is made once a month by a manager (a senior member of the sales staff) to compare a manual count of stock in the warehouse with those recorded on the system. When a discrepancy in stock levels is found, the stock level on the system is adjusted. The date and reason for the action must be recorded for audit purposes, as well as which manager made the change.

(b) Draw a use case diagram describing the main functions of the new system described above. Give a short description of each use case you have identified. State any assumptions you have made.

[10]

(c) Draw a class diagram, outlining the key classes and relationships that would be needed to support the activities identified in your use case diagram. You do not need to show the attributes and operations of your classes. Give a short description of the purpose of each class you have chosen and justify the associations between the classes.

[4]

(d) More detailed investigation of the problem reveals that the company also leases some high value tools (but not consumables) to customers who only require them for short periods of time. Customers are charged a daily fee for an agreed period,

as well as a deposit for the tool. When a customer returns a tool, they are refunded their deposit (assuming the tool is undamaged). If the tool is returned late, the customer is charged at a higher daily rate for the extra days of use. Explain how this change would affect the use case diagram and class diagram you have drawn.

[4]

3. (a) What is a software design pattern? A pattern description typically includes a description of the "forces" that apply to the pattern. In this context, what is meant by the term 'forces'?

The Adaptor, Façade and Proxy patterns are often grouped together as similar. Briefly describe what the three patterns have in common and explain what makes each of them different from the others.
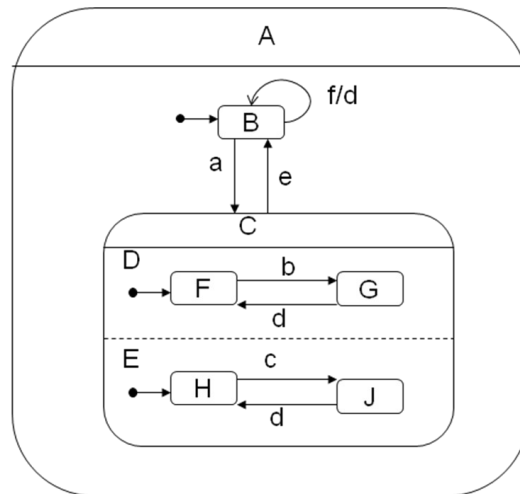
[6]

(b) What is the Liskov Substitution Principle? Consider the following class diagram. With reference to this design, identify an application of the Heterogeneous List pattern and explain how the Liskov Substitution Principle is illustrated by its use.

[5]
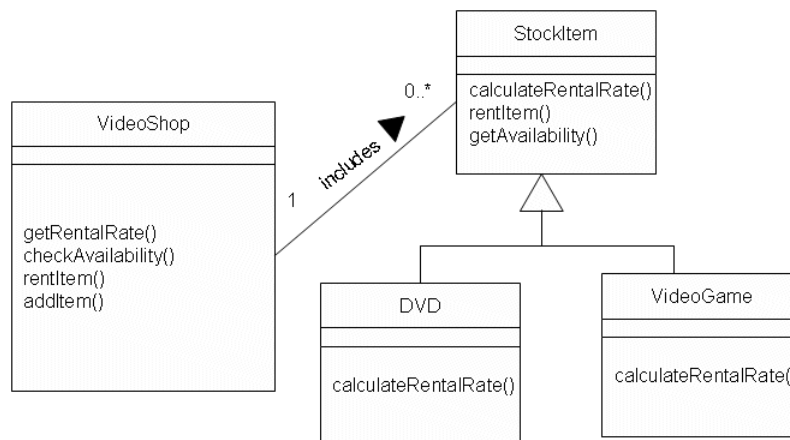
(c)

Explain the following statechart features with reference to the statechart above:

- Orthogonality
- Broadcast events

[4]

(d) Draw a component diagram to show three components (A, B, C) such that A uses an interface exposed by B and B uses an interface exposed by C.

In OSGi, how does a bundle make its interfaces known to the gateway. How is this information used by the gateway?

[5]

4.   (a)   The fragment below is extracted from the class diagram for an electronic voting system.
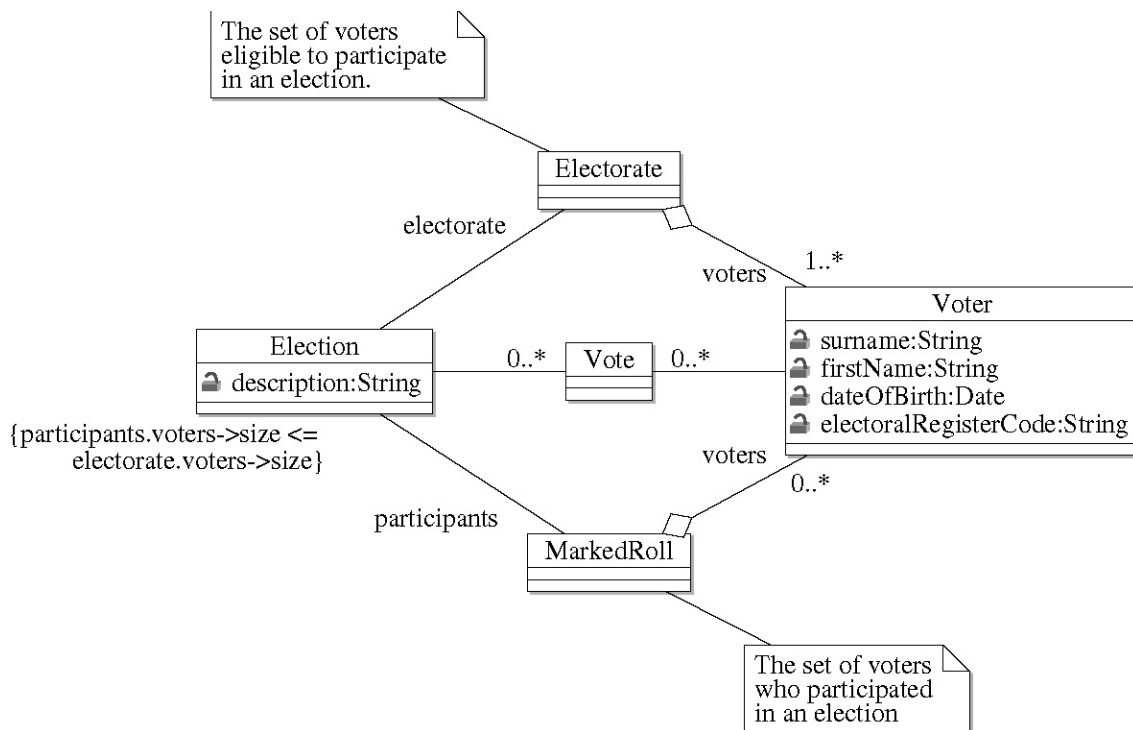
i)   Explain the constraints that are imposed on the relationships between the classes in the system.

[2]

ii)   Give a natural language explanation of the OCL statement associated with the Election class.

[2]

iii)   An election description is something like "Election of a Member of Parliament to serve in the constituency of Kirkcaldy and Cowdenbeath". Write an OCL constraint to restrict the length of the election description to 500 characters.

[2]

iv)   The number of votes cast in the election should be the same as the number of voters on the marked roll. Express this rule in OCL.

[3]

v)   A voter should only be able to cast at most one vote per election. Express this rule in OCL.

[3]

(b)   You are employed as a software developer for a semi-autonomous department of a larger company. Your department depends on a small number of 'mission critical' applications deployed on a legacy platform (hardware and software)

managed by the company. The company's Chief Technology Officer (CTO) has decided to retire the platform in the immediate short term because it is too expensive to maintain. Documentation and source code is only partially available for the legacy applications.

    i) Describe the process of re-engineering the legacy applications.

[3]

    ii) Discuss the feasibility of the CTO's proposal and, if appropriate, *briefly* describe and justify an alternative.

[2]

(c)   A colleague claims that your company has "too many legacy systems" inhibiting its productivity. What factors would you consider when you evaluate this statement?

[3]