Two hours

Section A and Section C are COMPULSORY

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Pattern-based Software Development

Date: Thursday 21st May 2015
Time: 14:00 - 16:00

Answer ALL of Section A
Section B: Answer Either Question B.1 OR Question B.2
and
Answer ALL of Section C

Use a SEPARATE answerbook for EACH Section.

This is a CLOSED book examination

The use of electronic calculators is NOT permitted
Section A

Answer All Questions

a) What is a software process? Why do we need software processes? (2 marks)

b) Concisely explain the four main stages in the incremental development process. (4 marks)

c) Concisely explain the four main stages of the extreme programming process. (4 marks)

d) Concisely describe what design patterns and GRASP principles are, and how they are related. (4 marks)

e) Briefly, without the use of a diagram, explain how the State pattern works. (4 marks)

f) Under what circumstances is it appropriate to use the State pattern and what is the most common alternative? (2 marks)
Section B
Answer ONE question from this section

Both questions in this section are based on the following scenario:

You are designing a software system which will help in the management of large hierarchical organisations such as armies, governments or universities. The aim is to provide a general-purpose system which can be customised for different organisations. The system will keep track of the personnel in an organisation, and also the material resources it requires.

All such organisations consist of sections, which have subsections, and so on. The software cannot make any assumptions about how many sections an organisation has or how many levels there are in the organisation. Also, different organisations have different names for their sections (e.g. “regiment”, “brigade” in an army or “faculty”, “school” in a university).

We can, however, assume that (i) Each section has a person who leads it, with a job title and a name, and (ii) Every organisation has a unit section, which is not divided further, but which normally has more than one member of staff (such as a platoon in the army).

Question B1

a) Draw a UML class diagram which shows how the Composite design pattern could be applied to model organisations as described above. (5 marks)

b) Explain how the collective skillset of all the people in an organisation could be calculated based on this design. Hint: this requires set operations, rather than integer ones. (3 marks)

c) Large organisations generally have large numbers of items of equipment, for example an army will have a very large number of bullets. Briefly explain what a factory is and state two advantages of using one in this situation. (3 marks)

d) Suppose we have a particularly conscientious army which wishes to keep track of every single bullet it possesses. A bullet can be in a number of states, e.g. in storage (at some place), allocated (to some unit), or used.

i) You could use the State pattern to represent the states of bullets, but briefly explain why this may not be necessary, and what you could do instead. (2 marks)

ii) Briefly explain the principle behind the Flyweight pattern. (2 marks)

iii) Explain how Flyweight could be applied to this particular situation, in a way that minimises the amount of storage required to represent bullets. (3 marks)

iv) How is the Flyweight pattern related to GRASP principles? (2 marks)
Question B2

a) i) *Data driven programming* means taking information out of the code and storing it as data which is read by the code. Explain how the **Interpreter** pattern uses, and extends, this idea. (2 marks)

ii) Different organisations (as described above) calculate overtime payments in broadly the same way, but details such as the total amount of overtime allowed vary both between organisations and between sections within them. How could the Interpreter pattern be used to enable us to calculate overtime payments without writing many different versions of the overtime calculation algorithm? (3 marks)

iii) How is the Interpreter pattern related to GRASP principles? (2 marks)

b) i) Airlines have aircraft which may be in one of several states, e.g. they may be in the air, on the ground being serviced, in a hanger being maintained etc. State changes may happen at any time (e.g. an aircraft may become unserviceable at short notice) and may need to be known about in multiple places. Explain how the **Observer** pattern can be used to deal with in this situation. (4 marks)

ii) Other organisations have similar situations but with different equipment and state changes. For example an ambulance service needs to keep track of its ambulances. Draw a UML class diagram to show how the Observer pattern can be used to track both airplanes and ambulances, in a way that can be extended (by adding extra classes) to other cases. (5 marks)

iii) The **Observer** pattern is often described as publish-subscribe, but explain, using examples from question b ii) above, the actual sequence of operations and where they are implemented. (4 marks)
Section C

Answer ALL Questions

The questions in this section relate to the design of a domain model for an online bookstore. The design reuses some transaction and accounting patterns you have learned from this course.

a) Use **two transaction patterns** to model the situation: “The customer has placed two books in her shopping basket.” Draw a UML class diagram to illustrate this model. (4 marks)

b) Name these patterns. Explain how they have been used in your model. (3 marks)

c) Explain the relationships between the domain classes and the meaning of the multiplicities on the relationships. (3 marks)

d) Extend your domain model so that it can include this situation: “The customer pays for the books by using her credit card and the bookstore’s internal accounting system records the sale by creating an accounting entry.” Use **two transaction patterns** and **two accounting patterns** to model this situation. Draw a UML class diagram to illustrate this model. (6 marks)

e) Name these four patterns. Explain how they have been used in your model. (4 marks)

END OF EXAMINATION