# Specification of Information Systems (19233030) Examination

6th April, 2011

Explain your answers, but keep them precise: short and to the point.

1. An MRI machine is a device that uses magnetic resonance to make images of the internal structure of the human body. It uses a powerful magnetic field to align the magnetization of some atoms in the body, and radio frequency fields to systematically alter the alignment of this magnetization. This causes the nuclei to produce a rotating magnetic field detectable by the scanner. This information is recorded to construct an image of the scanned area of the body. The strong magnetic field causes nuclei at different locations in the body to rotate at different speeds, which provides sufficient information to construct of 3-D spatial images.

   Consider the software of an MRI scanner. It contains subsystems (1) to control the scanner, (2) to construct an image of the scanned body, (3) to display an image on a screen, and (4) to send the image to an information system for storage.

   a. Define the concept of a subject domain, and illustrate this with the subject domain of one of the subsystems of the MRI control software.

   b Define the difference between physical entities, conceptual entities and lexical entities in a subject domain, and gives one example of each of these from the subject domain of some subsystem of the control software. (Different examples can come from different subject domains.)

   c. Define the difference between a reactive and a transformational system. Give an example of a reactive system and of a transformation system in the MRI scanner software.

   d. The entire software system of the MRI scanner has a subject domain too. (d.1) What is it? (d.2) Give an example of an event and an action in the subject domain. (d.3) The event and action differ from stimuli and responses. Explain.

2. A fan club of a popular music band offers music and gadgets to members of the club exclusively through its web site. The only condition is that a fan should order at least one item per quarter. Figure 1 shows three ERDs of this situation.

   a. ERDs (b) and (c) do not contain all relevant cardinalities that express the situation. Add the missing cardinalities.

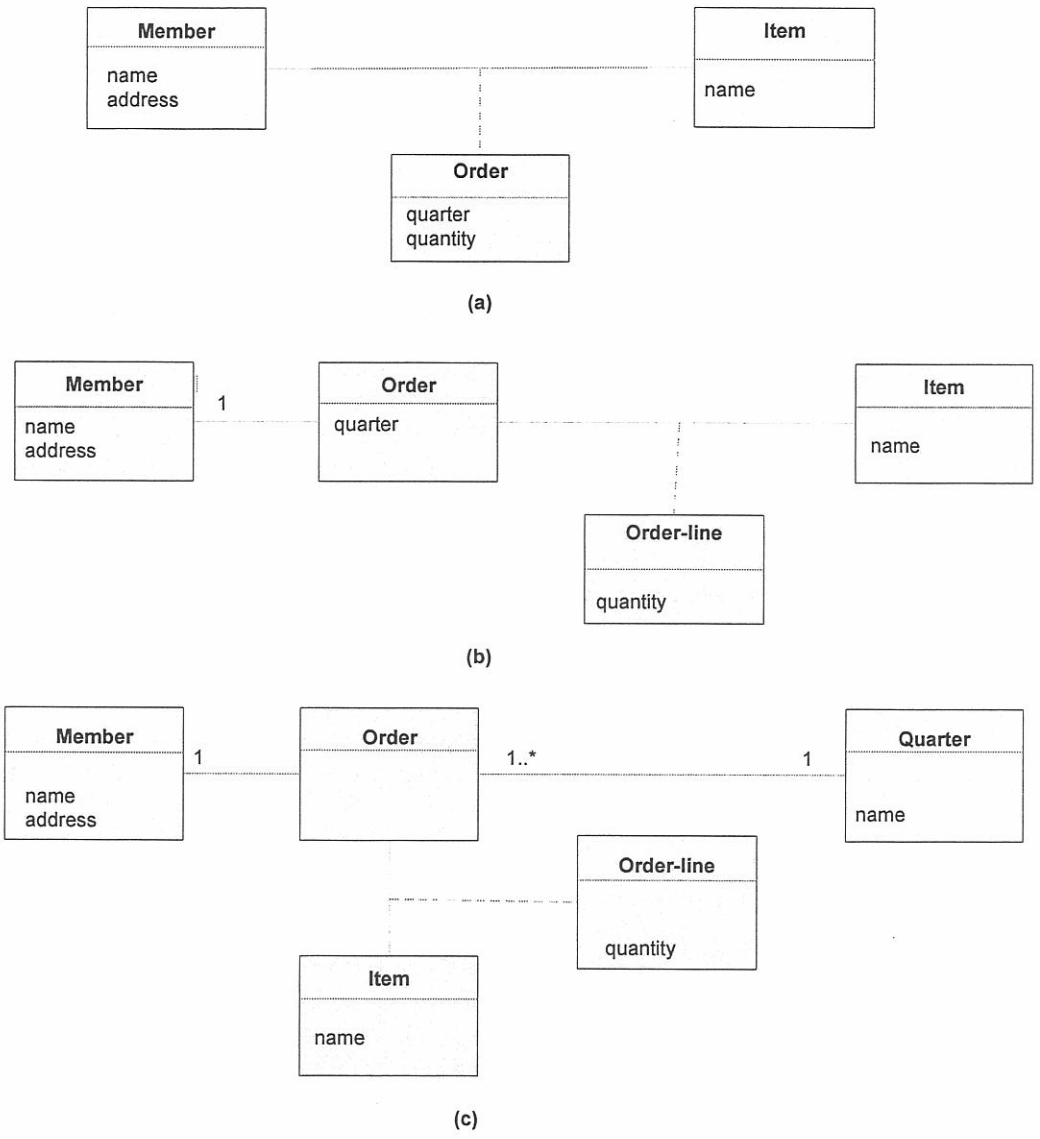


Figure 1: Some ERDs.

b. A member places an order for an exclusive gadget, and a few days later, in the same quarter, places a second order for the same gadget. Is this possibility expressed in model (a)? In model (b)? Explain your answers.

c. Express the constraint "Each member must order at least one item per quarter" as a natural language constraint on diagram (a) and as a natural language constraint on diagram (b).

d. Diagram (c) contains a relationship between Order and Quarter. Does this express the constraint "Each member must order at least one item per quarter" properly? Explain your answer.

3. Figure 2 shows a statechart for a book-lending process. A book is either in or out, and when it is out, the library can remind the borrower to return or extend the loan. If a borrower does not respond to the second reminder, the book is written off. (No doubt you can think of numerous improvements to this simplistic process. But we will use this simple process for the exercise.)

   (a) The diagram contains several after(t) events. Explain the meaning of these events.

   (b) Use state hierarchy to reduce the number of return and extend arrows in the diagram.

   (c) Use a local variable to count the number of reminders. Take care that this variable has a correct value at all times.

   (d) When a book is not checked in, it can be reserved. When it is reserved, its loan period cannot be extended. Add a parallel Reservation process to the diagram in which this is expressed.

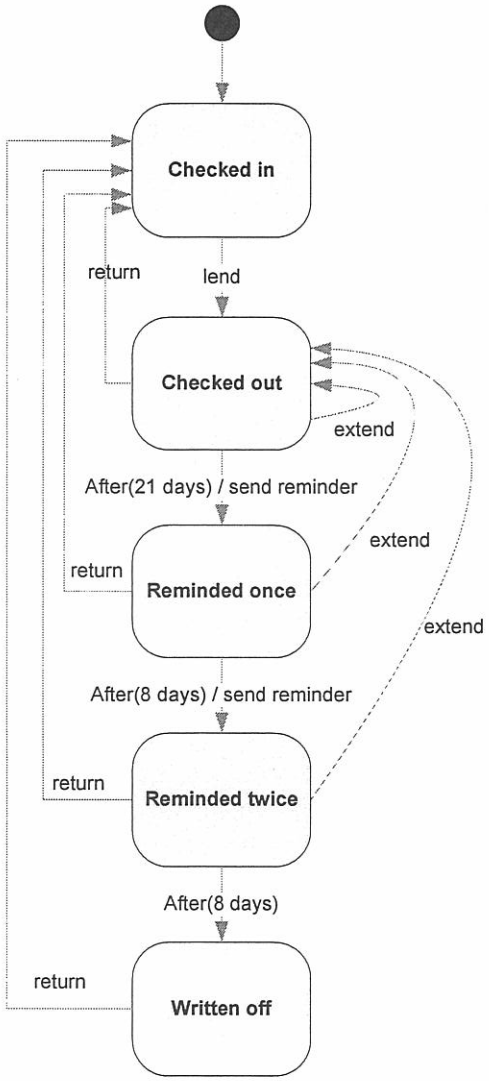


Figure 2: A Mealy diagram.

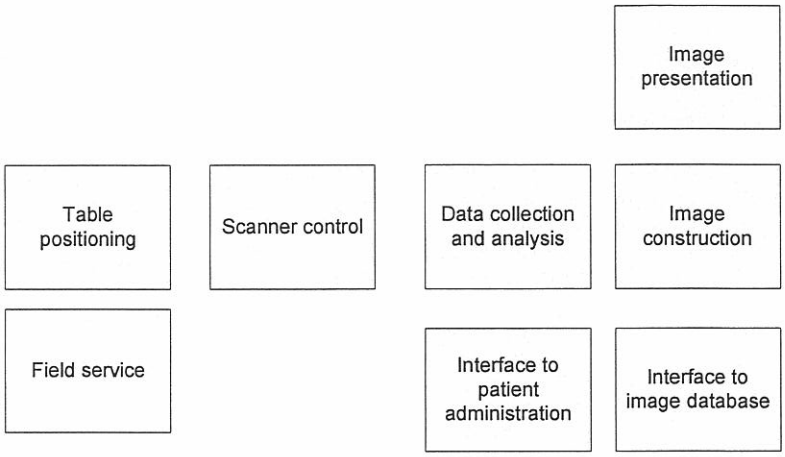


Figure 3: An architecture diagram.

4. Figure 3 shows a simplified architecture diagram of the MRI software. (It mentions more components than question 1 does, but is still greatly simplified compared to the real architecture.)

   a. There are four ways of decomposing a system: functional decomposition, subject-oriented decomposition, communication-oriented decomposition and behavior-oriented decomposition. Define these decomposition guidelines and illustrate them using the MRI software decomposition. (Communication-oriented decomposition is subdivided into several guidelines. You do not have to define these in detail.)

   b. What is the difference between an requirements-level and an implementation-level decomposition?

   c. There are two relationships between the components of a system and the composite system: (1) the components deliver a service to the composite and (2) the composite encapsulates the components, so that external entities can only interact with the components through the interface of the composite system. Use these two properties of decomposition to explain the difference between encapsulation and layering of a system.

   d. The context of the MRI software includes the scanning machine (containing scanners, table, and other devices), a patient being scanned, nurses preparing the patient for scanning, a radiologist using the machine, operators who keep the machine running, field personnel doping maintenance, the physical room that shields the machine from electromagnetic interference, and possibly other entities and actors. Give two criteria to determine the context boundary, and illustrate these using the MRI machine context.

| Problem | a | b | c | d | e | |
|---|---|---|---|---|---|---|
| 1 | 4 | 6 | 4 | 6 | | 20 |
| 2 | 6 | 6 | 6 | 6 | | 24 |
| 3 | 4 | 6 | 6 | 6 | | 22 |
| 4 | 8 | 4 | 6 | 6 | | 24 |
| | | | | | | 90 |

Grade = (10 + points)/10