UNIVERSITY OF LONDON
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 2001

MSc in Computing Science
for Internal Students of the Imperial College of Science, Technology and Medicine

PAPER M225

SOFTWARE ENGINEERING

Wednesday 2 May 2001, 14:00
Duration: 120 minutes

Answer THREE questions

Paper contains 4 questions
Calculators not required

Section A *(Use a separate answer book for this Section)*

1a Explain the terms *clustering, orthogonality* and *broadcast communication* in the context of statecharts, indicating what they add to state transition diagrams and why that are useful.

b A web-based book evaluation system is to be developed to model reader's response to book prices. Readers rate books as either *poor*, *OK* or *excellent* (by pressing the appropriate button). To begin with, a book's rating is *OK*. If a book's price is raised to over £30, then readers rate it as *poor*. If a book's price is dropped to less than £2, then it is rated by readers as *OK*. If the book gets good reviews in the press, then readers rate it as *excellent*, but only if the reviews are in a reputable newspaper. While the book's rating is *excellent*, it sells well, and while its ratings are *poor*, its sales drop.

i) Draw a state-transition diagram that models state of the books in the above system, indicating conditions and operations, where relevant.

ii) A book is published mainly in either hardback or softback, depending on its rating by readers. When a book's price is dropped to less than £2, it is published mainly in softback, but when ratings are reviewed and a book is rated as *poor*, it is published mainly as a hardback. By default, books are published in hardback. Extend the state transition diagram in part (i) into a statechart, taking into account the book's main publication cover (softback or hardback).

c State transition diagrams are well suited to describing use cases involving one object. Suggest and briefly explain an alternative notation for describing use cases involving multiple objects.

The three parts carry, respectively, 30%, 50%, 20% of the marks.

2a (i) Briefly distinguish validation and verification (V&V), and explain their role in Requirements Engineering.

(ii) Give an example of a V&V technique.

b Suggest an approach for making the requirements statement below more testable:

"the Internet-banking system shall be secure"

Illustrate your answer by re-writing the requirement.

c As part of the planning process for the next general election, your consultancy firm, Requirements Engineers Do It Once (REDO Ltd), is hired to elicit the requirements for a fully automated, Internet-based presidential voting system.

Discuss your approach for eliciting the requirements for such a system, focusing on the kinds if information you need to elicit, and how you plan to elicit this information. Be specific about the kind of techniques you suggest, indicating the impact of your choices on the final system.

d Once you have elicited the requirements for the system described in part (c), you discover that the Macrohard Corporation has an existing product called Polling on the Internet Securely (P.I.S.) that addresses some of the functionality required. Briefly discuss the process by which you would decide whether to build a new system from scratch or to the P.I.S. product and adapt it to your requirements.

The four parts carry, respectively, 20%, 15%, 45%, and 20% of the marks.

Section B *(Use a separate answer book for this Section)*

3a i) What is meant by *decorated inclusion* of one schema into another?

ii) Describe the use of the symbols Δ, Ξ, ! and ? in operation schemas.

iii) Consider the following schemas *Employee*, *Increment* and *Promotion*:

Employee

title: **seq** char
salary: N

Increment

salary, salary' : N
increment?: N

---

salary' = salary + increment?

Promotion

Δ Employee
Increment

---

title' ≠ title

Rewrite the schema *Promotion* without using schema inclusion.

b Describe what is a model of a schema (Assume that the schema does not have any base sort, i.e. no symbol in square brackets after the schema name.)

For each of the following schemas describe what would constitute a model. For schemas (i)-(iii) give an example of a model.

i)

SampleP

P: FN

$\forall x: N\ [x \in P \rightarrow \exists y: N\ (x = 2*y)]$

ii)

Succ

f: N → N

$\forall x: N\ f(x) = x+1$

iii)

SamplePQ

SampleP
Succ
Q: FN

$\forall x: N\ [x \in P \leftrightarrow f(x) \in Q]$

iv)

Sub

ΔSamplePQ
ΞSucc
number?: N

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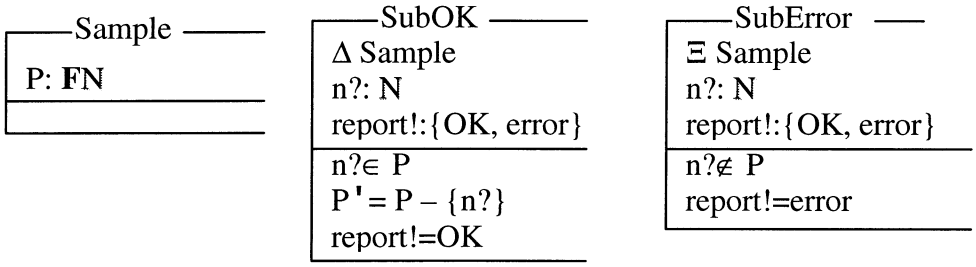
number? ∈ P
P' = P – {number?}
Q' = Q – {f(number?)}

The two parts carry, respectively, 40%, 60% of the marks.

4a Consider the following schemas *Sample*, *SubOk* and *SubError* and the schema disjunction *Sub* = *SubOK* ∨ *SubError*. Write out how the schema *Sub* would appear if written in full, using schema inclusion and Δ notation.



b An automatic booking system for a cinema allows people to book tickets over the phone using a credit card. The overall state of the system can be either *closed* or *open*, depending whether the cinema is closed or open. The system allows a customer to book one or more tickets and to refund tickets. Tickets can be booked or refunded only when the system is open. To book ticket(s), a customer provides a credit card number of type **seqN** and the number of tickets, and receives in return the number of tickets booked and a confirmation message. As for the refund, the customer has to provide instead the number of tickets he/she wants to be refunded. At each booking, the system updates directly the cinema's bank account. The following schema *Cinema* defines the basic parameters of the system.

Cinema

numberofseats: **nat**	(capacity of the cinema)
price: **nat**	(price per ticket)
status: {closed, open}	(when the cinema is closed or open)

i) Write a state schema *SystemState*, for the overall state of the system, covering the two cases when the system is open and closed. In both cases, the schema includes *Cinema*, uses the variables *accountbalance* (the balance of the cinema's bank account), *seatsleft* (number of seats left). Include relevant constraints on the variables.

ii) Write operation schemas for the following operations. They all have to include the input *numbertickets?*, *cardnumber?*, and the outputs *ticketsbooked!* and *report!*. Marks will be awarded for correct use of Δ and Ξ.

BookedOk bookes a requested number of tickets and updates the cinema's account balance.

SeatsUnavailable gives no tickets because the cinema does not have enough seats available.

CinemaClosed gives no tickets because the cinema is closed.

iii) Write an operation schema for the operation *Refund*, which includes the input *ticketstorefund?* and *cardnumber?*.

iv) Consider the operation *Booking* = *BookedOk* ∨ *SeatsUnavailable*. Is this operation total? Explain why.

The two parts carry, respectively, 30% and 70% of the marks.