UNIVERSITY OF LONDON
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 1998

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

This paper is also taken for the relevant examinations for the Diploma of Membership of Imperial College

PAPER M3.02

SOFTWARE ENGINEERING
Monday, April 27th 1998, 10.00 - 12.00

Answer THREE questions

For admin. only: paper contains 4 questions

1a Name and briefly distinguish three kinds of models that are commonly used in software development.

b Why are state-transition diagrams (STDs) unsuitable for modelling large and complex systems? Describe an adaptation of STDs that addresses some of their weaknesses.

c Normally, a lazy student spends his time either eating, drinking or sleeping. He starts every day sleeping, and when his alarm goes off, he wakes up and starts eating, but only if he has slept ten or more hours. When he is thirsty he drinks, and when he is hungry he starts eating again. Whenever he is sleepy, he goes to sleep.

i) Draw a simple STD that models the above student's behaviour. Include actions, conditions and activities, wherever they are applicable.

ii) Simplify the above STD using "clustering".

iii) During the examination period, the student also spends his time studying, waiting, or sitting exams. When he is in the mood, if he is not sleeping, he studies. When he is ready for his exam, he waits for the exam to start while biting his finger nails. Whether he is studying or waiting, when it is exam-time he sits the exam. While sitting his exam, whenever the student is sleepy, he resists the temptation to sleep.

Using orthogonality of statecharts ("AND-decomposition"), draw a statechart that extends the STD in part (i) to model the student's behaviour during the examination period, noting that if the student is hungry, he can only eat if he is not sitting an exam.

The three parts carry, respectively, 20%, 20%, 60% of the marks.

2a Name a strength and a weakness of the *waterfall model* of software development, and briefly discuss an alternative model that addresses its weakness(es).

b What is "information hiding" and why is it a good principle for software design?

c You have been asked to design the software component for a "stress-o-meter" - a device for measuring stress and analysing various psychological characteristics of people being interviewed for high-pressure jobs. The stress-o-meter analyses a blood sample from a subject, and based on some highly sophisticated algorithms and guidance from an operator, generates a detailed report on the subject, which is automatically sent by post to the company paying for the analysis. The report includes a number form 1 to 10 indicating the stress level of the subject, and a description of the subject's state of mind. Subjects are also asked to provide their name and address to the stress-o-meter.

i) Draw a *Context Diagram* to describe the scope of the stress-o-meter.

ii) The algorithms of the stress-o-meter work in the following way. Based on market research, stored in a database, about people living in different areas, the stress-o-meter generates one of a limited set of pre-defined reports. The blood sample provided by the subject is ignored, and instead a random number from 1 to 10 is generated. The random number and the report are merged into a final report delivered to the customer. The address provided by the subject is stored in a separate database for future use.

Draw an *Overview Data Flow Diagram* (DFD) to elaborate on the functionality of the stress-o-meter. Briefly explain the processes you include, and define the data flows in the diagram using a data dictionary.

d Briefly describe a weakness of DFDs and describe a complementary technique that addresses this weakness.

The four parts carry, respectively, 20%, 10%, 50% , 20% of the marks.

Turn over ...

3a What is *user-centred systems design* (UCSD)? Give one benefit and one drawback of applying UCSD to human-computer interface design. Suggest and briefly describe an alternative design approach.

b The London Ambulance Service (LAS) dispatch system failed in 1992 partly because of the design of the in-cab terminals installed for the use of ambulance crews. Designed originally for secure delivery vehicles, each terminal included a one-line display and 20 buttons, and was mounted above the dashboard, connected to the control centre by radio. At high speeds, ambulance crew members often pressed the wrong button and conveyed misleading status information to the control centre. In fact only four buttons were needed to indicate changes in status.

i) Briefly suggest how you think this design failure may have come about, in terms of the essential activities of user interface design.

ii) What steps would you take to design a better (and in particular, more usable) terminal?

c Briefly describe how you would evaluate the system described in part (b), indicating the expected products of the evaluation and why they are useful for re-designing the system.

The three parts carry, respectively, 25%, 40% and 35% of the marks.

4a Why do software engineers need to be aware of physical ergonomic issues when designing a human-computer system?

b Apart from personal preference, describe two factors that influence the choice of main input device for an automatic teller (cash) machine (ATM).

c i) Draw a *Hierarchical Task Analysis* (HTA) diagram for the joint task of finding flight destination/time using an airline reservation system that allows activities such as searching for flight details for a specific destination, and recording a reservation for a specific customer on a specific flight. Distinguish between user tasks, system tasks and joint tasks. Explain the notation you use.

ii) Suggest a dialogue style for interacting with the system in part (i).

d Briefly explain the role of standards in designing human-computer interactive systems. Why is it inappropriate to set industry standards for the user interfaces for emerging virtual reality systems?

The four parts carry, respectively, 10%, 20%, 50% and 20% of the marks.

End of Paper