UNIVERSITY OF LONDON

IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 1996

BEng Honours Degree in Computing Part II
MEng Honours Degrees in Computing Part II
BSc Honours Degree in Mathematics and Computer Science Part II
MSci Honours Degree in Mathematics and Computer Science Part II
for Internal Students of the Imperial College of Science, Technology and Medicine

This paper is also taken for the relevant examinations for the
Associateship of the Royal College of Science
Associateship of the City and Guilds of London Institute

PAPER 2.1 / MC2.1

SOFTWARE DESIGN I

Monday, May 13th 1996, 2.00 - 3.30

Answer THREE questions

For admin. only: paper contains
4 questions
5 pages (excluding cover page)

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

1a Briefly describe the *Waterfall* and *Spiral* models of software development. Comment on their ability to help ensure that the software system satisfies its customer requirements.

b In the interests of safety, a car manufacturer has provided the following set of detectors to help ensure that the driver's seat belt is fastened and that the door is closed:

S indicates that the seat is occupied
B indicates that the belt is fastened
D indicates that the driver door is closed

A warning buzzer should sound if the seat is occupied and either the belt is not fastened or the driver door is not closed. However, it should not sound if the seat is unoccupied or if the door is closed.

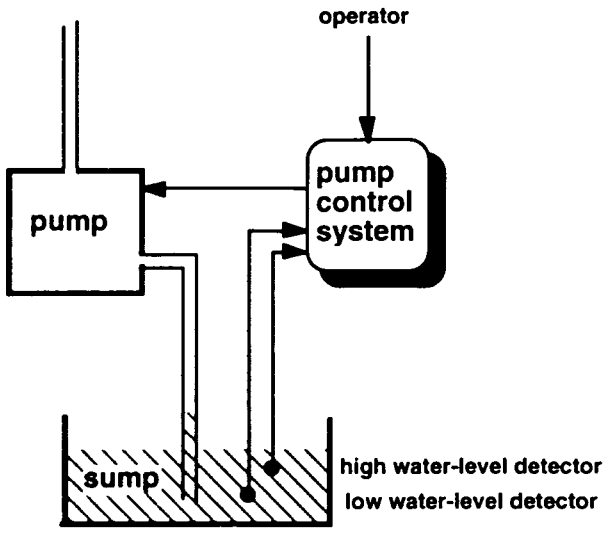
Draw a *Decision Table* which indicates the conditions under which the buzzer should be ON, and the conditions under which it should be OFF.

Show how you check that the table is *complete* and *consistent*, indicating whether or not this is the case for the table as specified. Show how you might correct the specification, if necessary.

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

2a The installation shown below is used to pump the water which collects in a sump. When enabled by the operator, the pump runs automatically, controlled by the water level sensors. Detection of high level causes the pump to run until low level is indicated. The pump should not run if disabled by the operator.

Given the events *enable* and *disable* generated by the operator, and *detect-high* and *detect-low* generated by the level sensors, draw a *State Transition Diagram* for controlling the pump. Include actions for switching the pump *on* and *off*.



b Give a *Statechart* for the pump controller in part a.

Briefly comment on why clustering is used in Statecharts and how it helps. Illustrate you answer using example(s) from the pump controller.

c How would you go about testing your pump controller specifications?

Illustrate your answer using an example from the pump controller.

The three parts carry, respectively, 40%, 40%, 20% of the marks.

Turn over ...

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

3a Write Smalltalk classes and methods to describe the way traffic lights control junctions:

i) Traffic lights exist in pairs of collaborating lights, ie one controlling the north-south traffic and the other controlling the west-east traffic. Traffic lights display a colour: red, green or yellow. Initially, traffic lights display red. They can change the colour displayed, after delaying for some time.

ii) A traffic light is notified when a car wants to cross in the direction controlled by this light.

iii) When a traffic light receives the message that a car wants to cross in the direction *it* is controlling, then if it has red colour it will request the collaborating light to turn to red. Otherwise, it will do nothing.

iv) When a traffic light is requested to turn to red, then

If it has green colour, it will delay and then it will turn to yellow and require the collaborating light to turn to green.

If it has yellow colour, it will delay and then it will turn to red and require the collaborating light to turn to green.

If it has red colour, it will do nothing.

v) When a traffic light is requested to turn to green, then:

If it has red colour, it will delay and then it will turn to yellow and require the collaborating light to turn to red.

If it has yellow colour, it will delay and then it will turn to green.

If it has green colour, it will do nothing.

vi) Traffic lights can be centralized or decentralized. Centralized traffic lights delay for the same time, which is controlled centrally. Decentralized traffic lights have their own delay time, which is set individually, and does not change.

b Write method expressions to do the following

i) Set the delay time for centralized traffic lights to 5.0.

ii) Create a centralized traffic light and assign it to T1, and a decentralized traffic light with delay time `12`, and assign to `T2`. Make `T1`, `T2` into a pair.

iii) Notify T1 that a car wants to cross. Notify T2 that a car wants to cross.

iv) Set the delay time for centralized traffic lights to `7.0`.

Note: For the delay use the class `Delay`, which enables the suspension of evaluation. The message

```
(Delay for seconds: aNum) wait
```

delays execution for `aNum` seconds.

The two parts carry, respectively, 80% and 20% of the marks.

4 The following describes loans for the purchase of cars:

i) A person has a name, an address and an age. A person may be working for one or more, but for no more than three companies. A person receives a salary from each company he/she works for. The disposable income of a person is the sum of all salaries received divided by their age and then decremented by a tenth of the sum of the prices of all the cars owned by this person.

ii) A car has a number plate, a horse power, and a mileage.A car may be owned by a person, a company or a bank. The price of a car is its horse power multiplied by 10000 and then divided by the mileage.

iii) A company has a name, an address, and a turnover (ie money received before paying the employees). The disposable income of a company is calculated as its turnover, decremented by the salaries of all employees.

iv) A bank has a name and an address.

v) Companies or people may apply to a bank for a loan to buy a car.

vi) The bank grants the loan to a person, if his/her disposable income exceeds the price of the car. The bank grants the loan to a company if its disposable income exceeds the price of the car.

vii) When a person or company receives the grant of a loan, then he/she/it sends back a letter of acceptance.

Draw an OMT class diagram describing the above. Indicate the type of the attributes, and the types of the arguments and results of the operations.

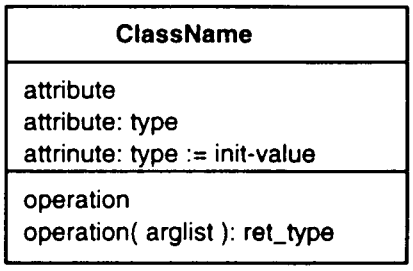
Note: Not *all* aspects of the above situation can be expressed in the OMT class diagram.

Note: On the last page you can find a summary of the OMT notation for object models.

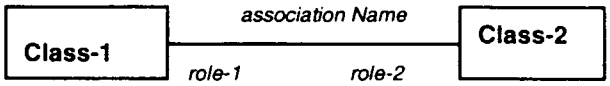
Turn over ...

OMT: Basic Notation for Object Models

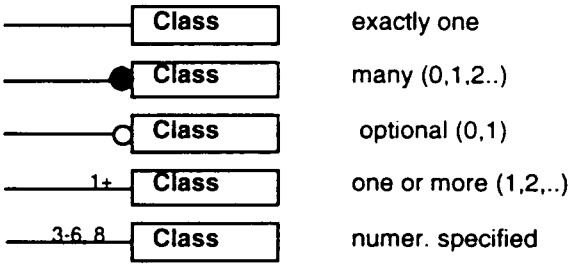
Class:



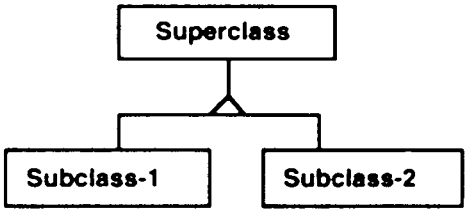
Association



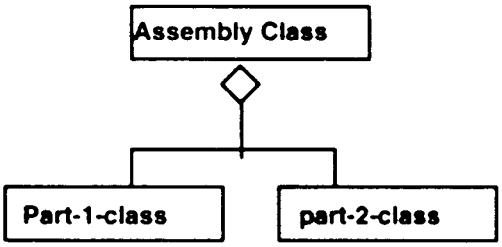
Multiplicity of Association/Aggregation



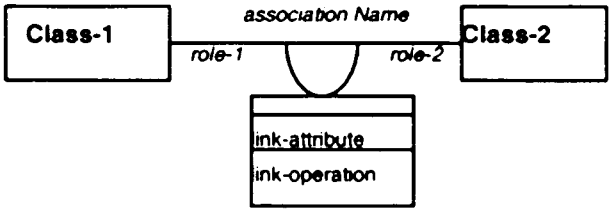
Generalization (Inheritance)



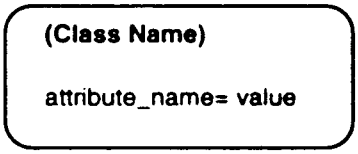
Aggregation



Link Attributes

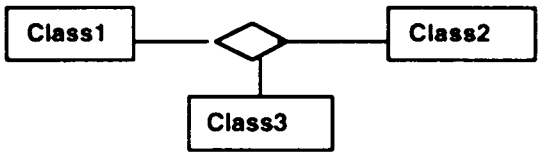


Object Instance



$ for class operations/attributes

Ternary Association



End of paper