Two hours

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Verified Development

Date: Monday 24th January 2011
Time: 14:00 - 16:00

Please answer Question ONE
and one other question from the remaining TWO questions available.

This is a CLOSED book examination

The use of electronic calculators is NOT permitted

[PTO]
1. **COMPULSORY**

   a) Briefly describe two advantages and two disadvantages of using model based development methods in industrial settings. (4 marks)

   b) What is the purpose of refinement? Briefly describe the main elements of a notion of refinement. (4 marks)

   c) Write down the *Contract Refinement Proof Obligations*, and briefly describe what they mean in words. Why is the *Contract Refinement Simulation Game* so complicated? (4 marks)

   d) In *Perfect*, what is the purpose of an invariant? In practice, most invariants can be omitted without damage to the program. Describe briefly the pros and cons of including versus omitting an invariant. (4 marks)

   e) In *Perfect*, suppose you have an integer variable $x$. Assuming you also have a schema $!\text{inc}$ that increments $x$ (by 1), write a *Perfect* property that says that $x$ modulo 3 is unchanged if you apply $!\text{inc}$ to $x$ three times. Why can you not do the same when 3 is replaced by a natural number valued variable $n$ say, and the $!\text{inc}$ schema is applied $n$ times to $x$? (4 marks)
2. A mobile phone network consists of phones, channels, and a notion of nearness of phones to one another. If two phones are near to one another, and there is a free channel, then the two phones can talk to one another, otherwise not. Write a `Perfect` class (and any additional material required) that models this situation, and includes functions/schemas to cope with the following situations.

a) Two phones become near to one another. (3 marks)

b) Two nearby phones talk to each other. (4 marks)

c) Two talking phones disconnect from each other. (4 marks)

d) Two nearby phones become far apart from one another. (4 marks)

e) Assuming a phone can act as a relay, two distant phones talk to one another via a third (unspecified) phone which they are both near to. (5 marks)

You are encouraged to make reasonable simplifying assumptions, but any such assumptions must be clearly stated. Minor errors of `Perfect` syntax in your answer will not be penalised excessively, provided the intended meaning is clear.
3. A stationery shop sells the following items: pencil, eraser, paper, pen, correction fluid. Each of these items is priced and sold individually. Write a Perfect class (and any additional material required) that models this situation, and includes functions/schemas to cope with the following situations.

a) Reporting the stock level of any item. (3 marks)

b) Setting the selling price of any item. (4 marks)

c) Selling an item. (4 marks)

d) Restocking an item. (4 marks)

e) Reporting the maximum income obtainable from the current stock level. (5 marks)

You are encouraged to make reasonable simplifying assumptions, but any such assumptions must be clearly stated. Minor errors of Perfect syntax in your answer will not be penalised excessively, provided the intended meaning is clear.