Two hours

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Verified Development

Date: Tuesday 17th January 2012
Time: 09:45 - 11:45

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
1. **COMPULSORY**

   a) Comment on the differences between purchasing software and purchasing other goods. Comment on the prospects of bringing these into line. (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 *Behavioural Refinement Proof Obligations*. State the *Behavioural Refinement Execution Trace Inclusion Theorem*. (4 marks)

   d) In a *Perfect* class, explain the purpose of the abstract and via sections. (4 marks)

   e) Briefly describe how *Perfect* uses various notions of refinement. (4 marks)
2. A conference chairman has to fix the budget of the conference he is organising. Costs are of two kinds: fixed costs, which do not change regardless of the number of participants, and, per-capita costs which grow in direct proportion to the number of participants. Write a *Perfect* class to model this situation, assuming that there is one fixed cost and one per-capita cost and including the capabilities below.

Data structures: (3 marks)

a) Set the fixed cost. (2 marks)
b) Set the per-capita cost. (2 marks)
c) Set the number of participants. (2 marks)
d) Set the conference participation fee. (2 marks)
e) Work out the profit earned from the set fixed and per-capita costs, the set participation fee, and the number of participants. (3 marks)
f) Work out the break-even number of participants, for given set costs and given participation fee. (3 marks)
g) Work out the break-even participation fee, for given set costs and given number of participants. (3 marks)

[N.B., “break-even”, means minimum possible to avoid financial loss.]

You can 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. Rupert, James, Rebekah, Tony and David are five managers who are playing a “blame game”. Write a `Perfect` enumerated class to contain these reprobates. Blame can be apportioned from $x$ to $y$ provided neither $x$ nor $y$ is already blaming someone. Write a `Perfect` class with the following capabilities.

Data structures: (3 marks)

a) Checking that blame can be apportioned from one reprobate to another. (3 marks)

b) Apportioning blame from one reprobate to another. (3 marks)

c) Checking that everyone blames someone. (3 marks)

d) Checking that Rupert blames everyone that does not blame themselves. (4 marks)
(Apologies to Bertrand Russell at this point.)

e) Assert the property in (d). (3 marks)

f) A bonus mark is available for an astute comment. (1 mark)

You can 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.

END OF EXAMINATION