<u>Two hours</u>

Question ONE is COMPULSORY

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Verified Development

Date: Friday 20th January 2017

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. **<u>COMPULSORY</u>**

a) Comment on the origins of the software crisis. How was software engineering *supposed to* help, and how did it *actually* help? (4 marks)

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

c) Explain the difference between a **property** clause and an **assert** clause in the *Perfect* language. (4 marks)

d) In the diagram below, the upper level is an abstract system and the lower level is a concrete system which is intended to be a behavioural refinement of it using the retrieve relation indicated by the dashed vertical lines. Write down the ways in which contract refinement fails. (4 marks)
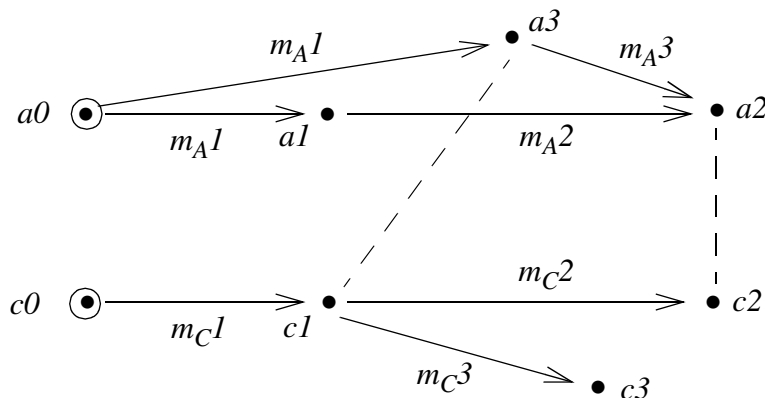
e) Define a **dual clause** as a **conjunction of literals**. Define **dual clausal form** as a **disjunction** of dual clauses. Write down the obvious dual analogue of a resolution step (a **dual resolution** step). Argue that dual resolution is sound for derivation of **truth**. (4 marks)

2.   A news service offers users channels that can be selected, and in each channel, there are topics. Channels and topics can be added by the service. Users can subscribe to channels and topics. Users have a favourites list, containing a maximum of five items (either channels or topics). Users select, or subscribe to an item, and it goes to the front of the favourites list, any excess items being discarded. Write a *Pefect* class to model this situation, containing elements as follows.

Data structures and invariants: (4 marks)

a)   News service introduces a channel.   (2 marks)

b)   News service introduces a channel topic.   (2 marks)

c)   User selects a fresh channel.   (4 marks)

d)   User selects a fresh channel topic.   (4 marks)

e)   User selects a favourites list element.   (4 marks)

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.   A university convenience shop sells the following six types of item: whisky, vodka, wine, beer, cider, ski yoghurt. 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.

Data structures and invariants.   (2 marks)

a)   Reporting the stock level of any item.   (2 marks)

b)   Setting the selling price of any item.   (2 marks)

c)   Withdrawing an item from sale.   (2 marks)

d)   Selling an item.   (2 marks)

e)   Restocking an item.   (2 marks)

f)   Reporting the income obtainable from selling an arbitrary five in-stock items. (Assume the total stock is at least five items.)   (8 marks)

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