Two hours

Question ONE is COMPULSORY

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Verified Development

Date: Monday 14th January 2013
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) Write down two strengths and two weaknesses of conventional (i.e. mainstream) software development. Write down two strengths and two weaknesses of formal (i.e. mathematical) software development.  (4 marks)

b) Assuming a (1,1) notion of refinement as follows:

\[
\begin{align*}
\text{IF} & \quad \text{THEN} \\
\begin{array}{c}
\quad u, i \\
\downarrow \quad R(u, v) \\
\downarrow \quad \text{In}(i, j) \\
\downarrow \quad \text{Proc}_C \quad \rightarrow \quad v', p \\
\downarrow \\
\end{array} & \quad \begin{array}{c}
\quad u, i \\
\downarrow \quad \text{Proc}_A \quad \rightarrow \quad u', o \\
\downarrow \quad R(u', v') \\
\downarrow \quad \text{Out}(o, p) \\
\downarrow \\
\end{array}
\end{align*}
\]

write down two questions connected with the coverage of the refinement that are left unanswered by the above.  (4 marks)

c) Write down the *Action Refinement Proof Obligations*. Briefly explain the purpose of each.  (4 marks)

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

e) In *Perfect*, what is the main use of contract refinement?  (4 marks)
2. An unknown performer called Barry Garlow has suddenly been given the task of organising a major concert that has to fit into a fixed timeframe. Many prominent artists want to perform their best hits and there is not enough time to fit all requests in. Write a Perfect class to model this situation including the following features. There should be a set of artists, a set of (offered) artist/song pairs, data about the duration of each song, and a schedule-so-far. There should be invariants to state that all songs are by selected artists, song/time information belongs to selected songs, and the schedule-so-far does not exceed the time limit. There should be class members as below.

Data structures: (3 marks)

Invariants: (3 marks)

a) Set the concert time limit. (2 marks)

b) Add an artist. (2 marks)

c) Add a song. (3 marks)

d) Set a song time. (3 marks)

e) Add to the schedule-so-far. (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 system for ripping CDs identifies a CD from the sequence of its tracklengths measured in microseconds. It refers to a databank of CD names and their sequences of tracklengths, by sending a hash of the tracklengths of the CD being ripped to a central location. Write a `Perfect` class with the following capabilities. There are CD names, sequences of tracklengths, and hash values. There is a hash function (which may be specified loosely), and a collection of class members as below.

Data structures: (3 marks)

Invariants: (3 marks)

a) Checking that a CD name is fresh. (3 marks)

b) Adding a CD name and its sequence of tracklengths to the database. (4 marks)

c) A `preidentify` function that returns a set of candidate sets of tracklength sequences from a hash value. (3 marks)

d) An `identify` function that returns a CD name from a given candidate set of tracklength sequences. (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.

END OF EXAMINATION