COMP31111

Two hours

Question ONE is COMPULSORY

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Verified Development

Date: Tuesday 26th January 2016

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

[PTO]

1. **COMPULSORY**

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) Explain what is gained in a rigorous development methodology by going from behavioural refinement to action refinement? (4 marks)

c) In *Perfect*, what is the purpose of an **`assert`** clause? (4 marks)

d) Write down the *Behavioural Refinement Trace Inclusion Theorem*. (You do not have to prove it.) (4 marks)

e) A typical resolution step looks like:

$$\frac{\Gamma\ (X_1, X_2 \ldots X_m, A)\ (\neg A, Y_1, Y_2 \ldots Y_n)\ \Delta}{\Gamma\ (X_1, X_2 \ldots X_m, Y_1, Y_2 \ldots Y_n)\ \Delta}$$

Explain what this means and why it is sound. (4 marks)

2. A rocket firing system work as follows. There are three explosive bolts to hold the rocket down while the engines start. The bolts are in the DISABLED state at the beginning. The controller send them a PRIME signal to enable them to fire. Once they are primed, the three engines are told to START. Once they are all started, the bolts are told to FIRE simultaneously. Write a *Pefect* class to model this situation. There should be sufficient invariants to check that the dependencies of the above description are maintained.

Data structures: (3 marks)

Invariants: (5 marks)

a) Control sends PRIME to each explosive bolt. (2 marks)

b) Explosive bolt acknowledges PRIME to control. (2 marks)

c) Control sends START to each engine. (2 marks)

d) Engine acknowledges START to control. (2 marks)

e) Control checks all bolts and engines. (2 marks)

f) Control simultaneously sends FIRE to all explosive bolts. (2 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.

[PTO]

3. There are five places, AA, BB, CC, DD, EE. Some of them are linked directly and those links can be travelled directly. There are three travel agents, ag1, ag2, ag3. Each travel agent has a computer system for storing travel possibilities, and calculating the fare for journeys, but the data has to be entered into the system by the agent. Of course, an agent can't enter a price without the link being there, nor enter a link without the places being there (let alone offer a price for a journey any of whose links are nonexistent or unpriced). Write a *Pefect* class to represent this situation as follows.

Data structures: (4 marks)

Invariants: (4 marks)

a) An agent enters a place. (2 marks)

b) An agent enters a link between places. (2 marks)

c) An agent enters a price for a link. (3 marks)

d) A customer discovers the best price for a three link journey by comparing the three agents' quotes. (5 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