
Formal Specification (*F22HO2*)

Class Test (Questions)

January 28, 2008

Write in handwriting you'd be happy to read — if I can't read it easily then I won't read it at all. You must consult the examiner about errors or ambiguities in this document. The examiner may decline to comment.

1. **(3 points)** Write the truth-tables for \wedge , \Rightarrow , and \neg .
2. **(7 points)** Fill in the types, using \mathbb{Z} symbol notation (not words):
 - $x : \mathbb{Z}$ and $x \in S$. (Type x and S .)
 - $S \subseteq T$ and $S : \mathbb{P}\mathbb{Z}$. (Type S and T .)
 - $\bigcup \mathcal{S}$ and $S \in \mathcal{S}$ and $S : \mathbb{P}PERSON$. (Type \mathcal{S} and $\bigcup \mathcal{S}$.)
 - $\emptyset \in S$ and $S : \mathbb{P}\mathbb{P}\mathbb{N}$. (Type \emptyset .)
3. **(10 points)** Write set expressions for (**all** answers must include the symbols $\{$, $\}$, $|$, and \bullet):
 - The set of odd integers (note that -3 is an odd integer).
 - The empty set of numbers.
4. **(15 points)** Suppose $S, T : \mathbb{P}\mathbb{Z}$ and $\mathcal{S} : \mathbb{P}\mathbb{P}\mathbb{Z}$.

Write down, with full types, \mathbb{Z} expressions for:

- $S \setminus T$ (the set subtraction of S and T).
- $\bigcup \mathcal{S}$ (the set union of all the elements of \mathcal{S}).
- $\bigcap \mathcal{S}$ (the set intersection of all the elements of \mathcal{S}).

Specification of a system.

The whereabouts of Evil Technicians who work in the Hive for the Umbrella Corporation need to be monitored for reasons of world domination.

You may assume a pure type *EVILTECH* of Evil Technicians.

5. (10 points)

- Using state variables $members : \mathbb{P}EVILTECH$, $inHive : \mathbb{P}EVILTECH$ and $outOfHive : \mathbb{P}EVILTECH$, write a schema for the state of the Hive.
- Write an initial state schema for the state of the Hive. Initially, all members are *outside* of the Hive.

In the question above note that:

- $members$ is just Evil Technicians who are members of the Umbrella Corporation.
- There is no numerical limit on the number of Evil Technicians inside or outside of the Hive (unlike the *ClubState* example which you have studied).
- No Evil Technician may be both in and out of the Hive.

6. (10 points) Write the following schemas (based on the *ClubState* examples you have already studied):

- $EnterHive$ (Evil Technician enters the Hive — they must be members and outside the Hive).
- $LeaveHive$ (Evil Technician leaves the Hive — they must be members and inside the Hive).

7. (10 points) Using only Z notation, write the preconditions of the schemas above.

8. (20 points) Using suitable error type and error-handling schemas, totalise the schemas above to $TotalEnterHive$, and $TotalLeaveHive$. Use the symbols \triangleq , \wedge , and \vee .

9. (15 points) Using variables $IsZombie? : \mathbb{P}EVILTECH$ and $IsZombie! : \mathbb{P}EVILTECH$, write a schema $Infects$ such that if there is a zombie Evil Technician outside the hive before $Infects$, then *all* Evil Technicians outside the hive are zombies after; similarly for inside the hive; otherwise there is no change.