EECS3342-Z Winter 2022
System Specification & Refinement
Example Exam Questions
April 16, 2022
Time Limit: 180 Minutes

Name (Print): _____

PPY Login _____

Signature _____

This exam contains 5 pages (including this cover page) and 5 problems.

Check to see if any pages are missing.

Do not detach any question pages from the booklet.

Enter **all** requested information on the top of this page before you start the exam, and put your **initials** on the top of every page, in case the pages become separated.

Attempt **all** questions. Answer each question in the boxed space provided.

The following rules apply:

- **NO QUESTIONS DURING THE EXAM.**
- **If a question is ambiguous or unclear, then please write your assumptions and proceed to answer the question.**
- Only writings within the designated answer boxes will be graded. Plan your answers on the sketch paper provided.
- **Write in valid Rodin ASCII syntax** wherever required.
- Where descriptive answers are requested, use complete sentences and paragraphs. Be precise and concise.
- In writing a sequent proof, only one inference rule can be applied at a time.
- Whenever the **ARI** inference rule is used, justify in writing its use.
- **Organize your work**, in a reasonably neat and coherent way, in the space provided. Work scattered all over the page without a clear ordering will receive very little credit.
- **Mysterious or unsupported answers will not receive credit**. A correct answer, unsupported by calculations or explanation will receive no credit; an incorrect answer supported by substantially correct calculations and explanations might still receive partial credit.
- All answers must appear in the boxed areas in this booklet.

Do not write in this table which contains your raw mark scores.

Problem	Points	Score
1	10	
2	10	
3	10	
4	10	
5	20	
Total:	60	

1. Given a model (with static and dynamic parts), what are the factors determining the number sequents generated for invariant preservation?

Solution:

- Number of (old and new) events
- Number of invariant conditions

[of 10 marks]

2. Justify whether or not the following statement is true:

A partial function is always a total function.

Solution:

- The statement is false.
- A partial function $f \in S \pfun T$ may have its domain $\text{dom}(f) \subset S$, which violates the requirement of a function being total (e.g., $\text{dom}(f) = S$).

[of 10 marks]

3. Can the left sequent below be transformed to the two right sequents via `OR_L`?

$$\boxed{\begin{array}{l} a+1>5 \lor a+1=5 \\ \vdash \\ a>0 \end{array}} \quad ?? \quad \boxed{\begin{array}{l} a>0 \\ \vdash \\ a+1>5 \end{array}} \qquad \boxed{\begin{array}{l} a>0 \\ \vdash \\ a+1=5 \end{array}}$$

Solution:

- No.
- By applying `OR_L`, the two disjuncts $a+1>5$ and $a+1=5$ should appear as separate antecedents, not separate goals. Also, the goal $a>0$ should not be transformed to a hypothesis.

[of 10 marks]

4. Consider the following action which intends to update the balance function $b \in ACCOUNT \pfun \mathbb{Z}$:

$$\text{b(a)} := \text{b(a)} + \text{v}$$

In valid Rodin ASCII syntax, rewrite the right-hand side of "becomes" operator using set and/or relational operators.

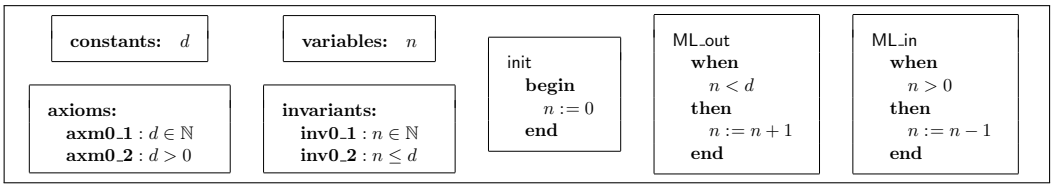
Solution:

- Acceptable answer 1: `a |-> b(a) + v  ({a} <<| b)`
- Acceptable answer 2: `b <+ {a |-> b(a) + v}`

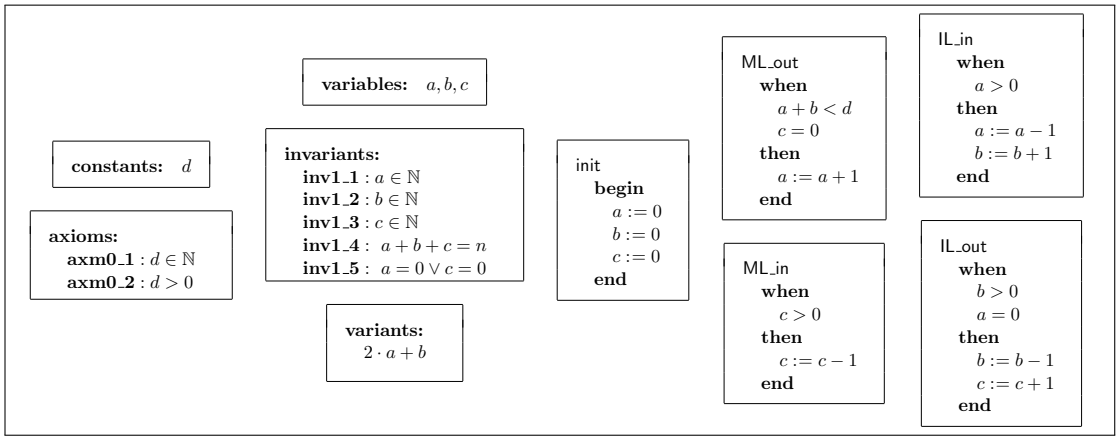
[of 10 marks]

5. Consider the following models of the bridge controller system:

m0: Initial Model

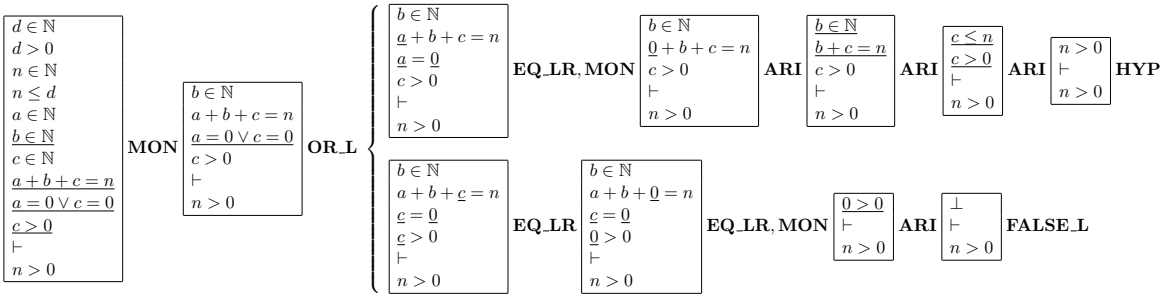


m1: First Refinement



Formulate and prove **ML_in/GRD**.

Solution:



It is also expected that each application of **ARI** is justified.

[of 20 marks]

This is a blank page for sketching purpose. You may detach it from the exam booklet.
Do **not** detach other question pages from the exam booklet.

This is a blank page for sketching purpose. You may detach it from the exam booklet.
Do **not** detach other question pages from the exam booklet.