University of Mohamed Boudiaf M'sila
Faculty of Mathematics and Computer Science
Department of Computer Science
Master 01 SIGL

Duration: 1h30 (90 Minutes) Instructor DR. Hichem Debbi

Formal Verification and Specification
Final Exam
May 23, 2023

True/False

(03 points) Write True if the statement is true, otherwise write False.

________ $F\psi \equiv \psi \vee XF\psi$

________ nuSMV is a symbolic model checker

________ Equivalence checking is based on the abstraction/refinement principle.

________ It is not possible to implement an abstract machine without passing by the refinement step

________ pWq is true, if only if q is true

________ In B method, properties are predicates on constants

Section 2. Short Answer(02 points)

1. What is the difference between a liveness property and a safety property. Give an example for each one ?
2. Cite four (04) formal specification languages ?

Section 3. Method-B Specification(07 points)

3. Suppose that we have the following problem: The computer science department has a number of available *Datashows*:

   ——— Abstract Machine
   MACHINE data_show_reserv
   SETS DataShows; /* abstract set of datashows */
   reserved = ok, ko /* datashow used or not */
   CONSTANTS max_Rsrc /* limit */
   PROPERTIES max_Rsrc : 1..MAXINT
   ....

   1- Complete the abstract machine data_show_reserv by adding invariants, initialization, and the three following operations:

   - **reserve**: for reserving a datashow.
   - **free**: frees up a datashow
   - **isReservedDatashow**: Checks whether a datashow is reserved or not.

2- Create an implementation for this abstract machine using arrays as total functions (Symbol: $-- >$))

Section 4. ω-expressions(04 points)

4. Give the $\omega-$regular expressions for the following Büchi automaton :

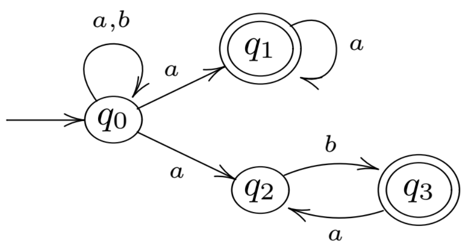

Figure 1: A

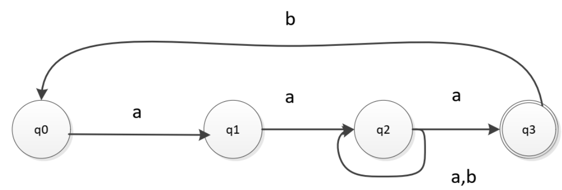

Figure 2: B

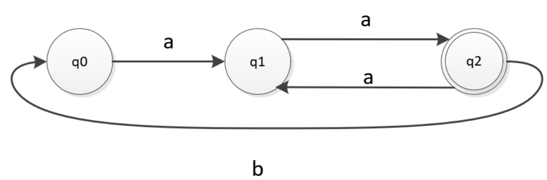

Figure 3: C

Section 5. CTL(04 points)

5. Consider the kripke structure presented in the figure below

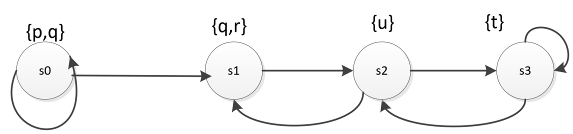

Figure 4: A Kripke structure

1- Construct its corresponding tree.
2 - Identify the set of states in which the following CTL properties are satisfied. Justify your response textually or by providing paths.

- EGq
- $EF(\neg r \wedge EXr)$
- $AGEGp$

Answer Key for Exam A

True/False

(03 points) Write True if the statement is true, otherwise write False.

True $F\psi \equiv \psi \vee XF\psi$

True nuSMV is a symbolic model checker

False Equivalence checking is based on the abstraction/refinement principle.

False It is not possible to implement an abstract machine without passing by the refinement step

False pWq is true, if only if q is true

True In B method, properties are predicates on constants

Section 2. Short Answer(02 points)

1. What is the difference between a liveness property and a safety property. Give an example for each one ?

   Answer: See course.

2. Cite four (04) formal specification languages ?

   Answer: See course.

Section 3. Method-B Specification(07 points)

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   - **isReservedDatashow**: Checks whether a datashow is reserved or not.

   2- Create an implementation for this abstract machine using arrays as total functions (Symbol: $-- >$))

   Answer:

Section 4. ω-expressions(04 points)

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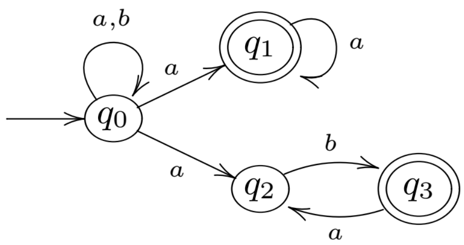

Figure 5: A

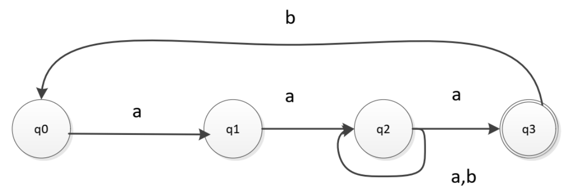

Figure 6: B

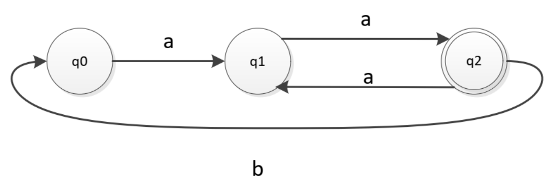

Figure 7: C

Answer:

- $(a+b)^*a^\omega + (a+b)^*a(ba)^\omega$
- $(aa(a+b)^*ab)^\omega$
- $((aa)^+b)^\omega + ((aa)^+b)^*a^\omega$

Section 5. CTL(04 points)

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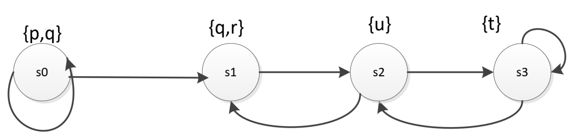

Figure 8: A Kripke structure

1- Construct its corresponding tree.
2 - Identify the set of states in which the following CTL properties are satisfied. Justify your response textually or by providing paths.

- EGq
- $EF(\neg r \wedge EXr)$
- $AGEGp$

Answer:

- only in s0. $s0$ infinantely
- is satisfied in all states. There is a path starting from s, such that in some state in the future $\neg r$ holds and such that in some next state r holds. The set of all states with $\neg r$ such that there exists a next state with r is $\{s0, s2\}$. Since we can reach $s0(ands1)$ from all states the formula holds for all states.

- There is no state ($\emptyset$). For every path starting in s, in each state on this path, EG t must be true, i.e., it is possible to find a path starting there where p is always true. Example: in $s0$ the property EGp holds, but not always since from s1 on there is no path satisfying the property.