

Midterm : CS 4271: Critical Systems and their Verification

1.5 hours

Instructions to Candidates

- Answer **ALL** questions.
- Answers must be written in the space provided in this booklet; **otherwise they will not be graded.**
- All answers **MUST** come with the correct explanations. There is no credit for guessing. A correct answer without the correct explanation will receive no marks.
- This is an **OPEN BOOK** examination. You are allowed to bring in any books/lecture notes etc.
- You can ask for extra sheets for rough work.
- **PLEASE WRITE YOUR MATRICULATION NUMBER BELOW.**

MATRICULATION NO.:

(This portion is reserved for the examiner's use only)

Question	Marks
Question A 6	
Question B 7	
Question C 4	
Question D 4	
Question E 4	
TOTAL 25	

A. 6 marks

Consider the following program with two threads, which are composed asynchronously. Assume that initially $A = 0$, and each assignment is executed atomically. What are the possible contents of the array X when the program terminates? Explain your answer, preferably without referring to the Kripke Structure of the asynchronous composition.

```
Thread 1: (A := 1; A := 2)
composed with
Thread 2: (X[1] := A; X[2] := A)
```

B. 6+1 marks

Specify the multi-threaded program in the last question in SMV. Your specification should also describe a temporal property which you think should be true for the program.

C. 4 marks

Let φ be a state formula and let s, s', s'' be states of a Kripke Structure M . Suppose $M, s \models EF\varphi$. Also, s' is a state reachable from s and s'' is a state from which s is reachable. No other information is known about M .

1. Does $M, s' \models EF\varphi$? Justify your answer.
2. Does $M, s'' \models EF\varphi$? Justify your answer.

D. 4 marks

Construct an Linear-time Temporal Logic (LTL) formula to describe the following property; assume that p is an atomic proposition.

“a state satisfying p occurs at most once along any path”

Also, construct a Kripke Structure which satisfies the above temporal property.

E. 4 marks

Construct a CTL formula which is satisfied by the initial state of the system model in Figure (a), but not satisfied by the initial state of the system model of Figure (b). Since we have shown only the valuation for the atomic proposition q in the different states, it will be the only atomic proposition appearing in your formula. Explain your answer.

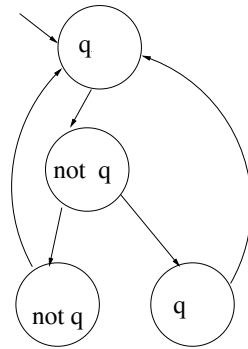


FIGURE (a)

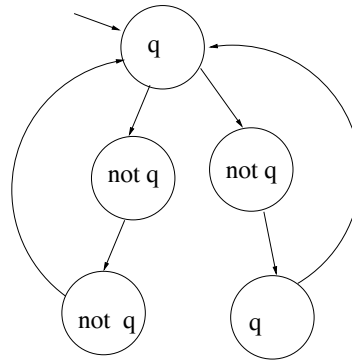


FIGURE (b)

END OF PAPER