CS 512: Formal Methods Spring 2016

Assignment 8: LTL, CTL, Traces and Execution Paths in Transition Systems

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1 Problem 1

a)
No. Starting from $s_0, \pi \vDash \{s_0, (s_3, s_4, s_0)^*\}$

b)
Yes. There is no infinite path that does not pass a state where $\neg p$ is true at one point.

c)
This is also true. Starting from s_0 you can either go to s_1, which satisfies the condition (P $\wedge$ X P), or you go to s_3, and then s_4, s_0 which also satisfies the condition. So there is no path that doesn't satisfy the condition at least once in the future.

2 Problem 2

a)
No for the same reason as 1.a, you can go down the same path $\pi \vDash \{s_0, (s_3, s_4, s_0)^*\}$

b)

Yes for the same reason as 1.b, there is no infinite path that does not pass a state where $\neg p$ is true at one point.

c)
No, because the $\forall$Xp will not be satisfied if you go from s_0 to s_3 because the immediate next is not also true.

3 Problem 3

As seen in problems 1.c and 2.c, directly substituting a $\forall$ will not translate LTL to CTL. The LTL formula F X p is satisfiable because there will be some future state where p is true no matter what path is taken. On the other hand, the CTL formula $\forall$ F X p is not satisfiable because from the initial state you can go to s_3 which is $\neg$ p and violates the forall condition.

4 Problem 4

a)
Infinite loop back to start : (abb)
Reaching end states : (ab)
You can also reach end state s_2 by repeating a*
Combined all together = (abb)*aba*

b)
Infinite loop back to start : (abb)
reaching end states : (ab)
continuing at state s_2 : a
continuing at state s_4 : (bab)
Combined all together = (abb)*ab(a + bab)^w

c)
Yes there is a path there. At some future point, p implies the next next state will be p forever. An infinite path $\pi \vDash ab(a)^w$ satisfies this condition.
The trace for that path is pp$(\neg p)^w$