LTL Model Checking

Problem 2. Consider the following transition system, $\mathcal{M} = (S, \rightarrow, L)$, where

- $S = \{0, 1\}$ is the set of states,
- $I = \{0\}$ is the set of initial states,
- $\rightarrow = \{(0,0), (0,1), (1,0)\}$ defines the transition relation,
- $AP = \{p, q\}$ is the set of atomic propositions, and
- $L : S \rightarrow 2^{AP}$ is the labeling function where $L(0) = \{p, q\}$ and $L(1) = \{p\}$.

Check the property *always, if p holds, then in the next state q holds*, which can be written in LTL as a formula ϕ, where $\phi = G(p \rightarrow X\ q)$, by performing the following:

a. Convert $\neg\phi$ to a transition system using the online tool located at

   `http://www.lsv.fr/~gastin/ltl2ba/index.php`

b. Draw the transition system for $\neg\phi$ as a Büchi Automaton $A_{\neg\phi}$ as described in class, where transitions are labeled with subsets of the atomic propositions AP.

c. Draw the transition diagram for $\mathcal{M}$.

d. Convert the transition diagram $\mathcal{M}$ into a Büchi Automaton $A_{\mathcal{M}}$ by adding the extra initial state and putting the labels, as subsets of AP, on the appropriate transitions.

e. Construct the product automaton $A_{\mathcal{M}} \times A_{\neg\phi}$.

f. Determine if there is an infinite path in the product automaton that visits an accepting state infinitely often. If so, give an example of this path, and in addition, give a path in the original transition system $\mathcal{M}$ that corresponds to this counter example. If there is no such accepting path in the product automaton, simply state this fact.