Exercise 1: Checking regular safety properties  
3 Points  
Consider the following transition system $TS$ over the atomic propositions $AP = \{a, b, c\}$.

In the lecture we have seen an algorithm for checking regular safety properties. The safety property $E$ was given as an NFA $A$ that was accepting the bad prefixes of $E$. The algorithm first computes the product $TS \otimes A$ and then checks whether the invariant $\neg F$ holds, where $F$ is the set of final states of $A$. If the invariant holds for $TS \otimes A$, then the property $E$ holds for $TS$. Otherwise, the property $E$ does not hold and the algorithm returns a sequence of states of $TS$ as an error indication.

Apply the algorithm for the properties that are given by the following NFA. 

(a) $A_1$ : 

(b) $A_2$ : 

Exercise 2: Non-blocking symbolic NFA  
1 Point  
Consider the following DFA (i.e., deterministic NFA) $A$ over the alphabet $\Sigma = 2^{AP}$, where $AP = \{a, b, c\}$.

Give a non-blocking DFA $A'$ such that both automata accept the same language (i.e., $L(A') = L(A)$).
Exercise 3: Büchi automata I  2 Points
Describe the $\omega$-languages of the following Büchi automata over the alphabet $\Sigma = \{A, B\}$. You may use $\omega$-regular expressions or natural language.

(a) 

(b) 

Exercise 4: Büchi automata II  1 Point
Construct a Büchi automaton over the alphabet $\Sigma = \{A, B\}$ whose language consists of all $\omega$-words that contain only finitely many $A$.

Exercise 5: Minimal bad prefixes  1 Point
Provide an example for a regular safety property $P_{safe}$ over some set of atomic propositions $AP$ and an NFA $A$ for its minimal bad prefixes such that

$$L_\omega(A) \neq (2^{AP})^\omega \setminus P_{safe}$$

when $A$ is viewed as a Büchi automaton.

Exercise 6*: Inclusion  1 Point
In the algorithm for checking regular safety properties we exploited the following equivalence for languages $L_1, L_2 \subseteq \Sigma^*$ for some alphabet $\Sigma$.

$$L_1 \subseteq L_2 \text{ iff } L_1 \cap \overline{L_2} = \emptyset$$

Here, we use $\overline{L_2}$ to denote the complement $\Sigma^* \setminus L_2$.

Show that this equivalence holds.