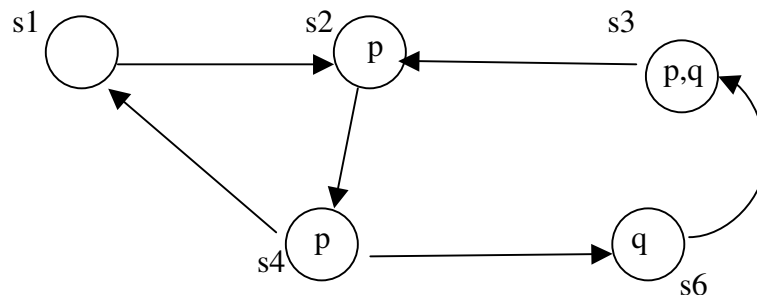
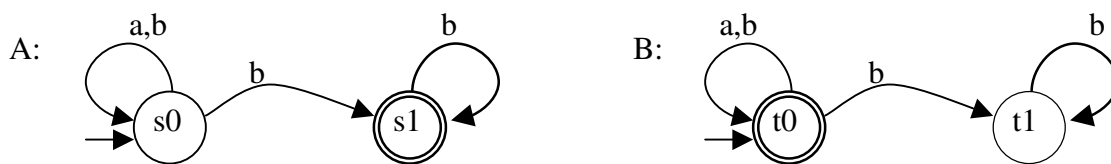


1. [2 points] Use the *labelling algorithm* to find the states of the following transition system that satisfy the CTL formula $AXE[p \cup q]$:



2. [2,5 points] Consider the following two Büchi automata:



- What infinite language is recognized by the leftmost automaton A?
 - Construct a Büchi automaton recognizing the $L_\omega(A) \cap L_\omega(B)$. Is this language empty?
3. [1 point] For each of the following pairs of CTL formulae exhibit a model in which one formula is true but not the other:
- $AF(p \wedge q)$ and $AFp \wedge AFq$
 - $A[p \cup q]$ and $A[p \text{ W } q]$
4. [1 point] Let σ be a state such that with $\sigma(x) = 0$ and $\sigma(y) = 1$. Give a derivation to determine the final state σ' of the command $x := y + 1; y := x + 1$ when starting from the initial state σ .
5. [1 point] For each of the following cases, give an example of a command C that satisfies the Hoare triple for total correctness, or argue why such an example does not exist:
- $\{true\} C \{true\}$
 - $\{true\} C \{false\}$
 - $\{false\} C \{true\}$
 - $\{false\} C \{false\}$
6. [2,5 points] Consider the following Hoare triple of a command computing the absolute value of the difference of two positive integers n and m:
- ```

{true}
z := 0;
if (m > n) then
 while (m - z ≠ n) do z := z + 1 od
else
 while (m + z ≠ n) do z := z + 1 od
fi
{z = |m - n|}

```
- Give a proof outline for *partial* correctness.
  - Give a proof outline for *total* correctness.

The final score is given by the sum of the points obtained.