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

```
\begin{align*}
  &s1 \quad s2 \quad s3 \\
  &\quad p \quad p,q \\
  &s4 \quad q \quad s6
\end{align*}
```

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

- **A:**
  - $a,b$
  - $b$
  - $s0 \rightarrow s1$

- **B:**
  - $a,b$
  - $b$
  - $t0 \rightarrow t1$

a) What infinite language is recognized by the leftmost automaton A?
b) 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:

a) $AF(p \land q)$ and $AFp \land AFq$
b) $A[p \ U q]$ and $A[p \ W q]$

4. **[1 point]** Let $\sigma$ be a state such that with $\sigma(x) = 0$ and $\sigma(y) = 1$. Give a derivation to determine the final state $\sigma'$ of the command $x:=y+1; \ y:=x+1$ when starting from the initial state $\sigma$.

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:

a) $\{true\} C \{true\}$
b) $\{true\} C \{false\}$
c) $\{false\} C \{true\}$
d) $\{false\} C \{false\}$

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 \neq n) do z := z + 1 od
  else
    while (m + z \neq n) do z := z + 1 od
  fi
{z = |m - n|}
```

a) Give a proof outline for\textit{ partial correctness}.
b) Give a proof outline for\textit{ total correctness}.

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