1. [1 point] Translate each of the following sentences in a linear time temporal logic formula:
   a) property P eventually becomes false;
   b) eventually property P becomes invariantly true;
   c) as long as the property Q does not hold, the property P will hold;
   d) if property P holds now and it is always the case that if property P holds at a certain time
      then property P holds also at the next instant in time, then P always holds.

2. [2 points] Use the labelling algorithm to give the set of all states of the following transition
   system satisfying the CTL formula E[p U AF q]:

3. [1 point] Give a CTL model with a state s₀ satisfying the formula AFp ∧ AFq but not
   satisfying AF(p ∧ q).

4. [2 points] Give a derivation for calculating the final state σ' of the following command
   \[
   \text{if } x < 3 \text{ then } x := 3+y \text{ else } x := 3 \text{ fi}
   \]
   when starting from an initial state σ with σ(x) = 2 and σ(y) = 1.

5. [2 points] Calculate the weakest precondition of the following command
   \[
   a[j] := a[i]; a[a[j]] := i
   \]
   with respect to the postcondition a[j]=i, where a is an array of positive integers, and i, j
   are two positive integers.

6. [2 points] Give a proof outline for the total correctness of the following Hoare triple:
   \[
   \{ 0 \leq n \} \\
   x := 1; \\
   y := n; \\
   \text{while } y \neq 0 \text{ do} \\
   \quad y := y-1; \\
   \quad x := 2*x \\
   \text{od} \\
   \{ x = 2^n \}
   \]

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