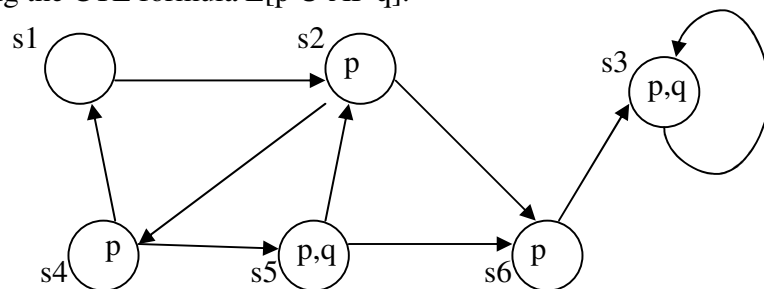


- [1 point] Translate each of the following sentences in a linear time temporal logic formula:
 - property P eventually becomes false;
 - eventually property P becomes invariantly true;
 - as long as the property Q does not hold, the property P will hold;
 - if property P holds now and it is always the 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 points] Use the labelling algorithm to give the set of all states of the following transition system satisfying the CTL formula $E[p \cup AF q]$:



- [1 point] Give a CTL model with a state s_0 satisfying the formula $AFp \wedge AFq$ but not satisfying $AF(p \wedge q)$.
- [2 points] Give a derivation for calculating the final state σ' of the following command

$$\underline{\text{if}} \ x < 3 \ \underline{\text{then}} \ x := 3 + y \ \underline{\text{else}} \ x := 3 \ \underline{\text{fi}}$$

when starting from an initial state σ with $\sigma(x) = 2$ and $\sigma(y) = 1$.

- [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.

- [2 points] Give a proof outline for the total correctness of the following Hoare triple:

$$\begin{array}{l}
 \{ 0 \leq n \} \\
 x := 1; \\
 y := n; \\
 \underline{\text{while}} \ y \neq 0 \ \underline{\text{do}} \\
 \quad y := y - 1; \\
 \quad x := 2 * x \\
 \underline{\text{od}} \\
 \{ x = 2^n \}
 \end{array}$$

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