1 Structural Properties of Petri Nets and Token Game

Given is the following petri net $N_1$:

![Petri Net Diagram](image)

a) What are the pre and post sets of transitions $t_5$ and $t_8$ and of place $p_3$?

b) Which transitions are enabled after $t_1$ and $t_2$ fired?

c) Determine the number of tokens in $N_1$ before and after $t_2$ fired.

d) Play the token game for $N_1$ and construct the reachability graph.

*Hint:* You may denote the states in such a way that the index indicates the places that hold a token in this state, for example $s_0 = (1, 0, 0, 0, 1, 0, 0, 0, 0, 0) =: s_{1,5}$. 
2 Basic Properties of Petri Nets

Given is the following petri net $N_2$:

Explain the terms *boundedness* and *deadlock-freeness* using this example, i.e. for which values of $k \in \mathbb{N}$ is the petri net $N_2$ bounded/unbounded and not deadlock-free?

3 Mutual Exclusion

Your task is to model a system as a petri net in which two processes want to access a common exclusive resource. This means that the two processes have to exclude each other mutually from the concurrent access to the resource (e.g. a critical program section). More concrete, this means:

1. A process executes its program.
2. In order to enter the critical section, a given mutex variable must be 0.
3. If this is the case, the process sets the mutex to 1 and executes its critical section.
4. When done, it resets the mutex to 0 and enters an uncritical section.
5. Then the procedure starts all over again.