Exercise 1: Terminology
In your own words, shortly describe what the following terms mean. In particular, state the difference.

(a) cyber-physical system
(b) embedded system
(c) dynamical system
(d) hybrid system
(e) transition system
(f) system model

Exercise 2: Formal approach
The lecture follows a formal approach for modeling and analyzing hybrid systems. Shortly describe typical advantages and disadvantages of formal approaches.

In particular, comment on the following statement.

"With a formal model of a system and a positive formal verification result that the specification holds, the system is guaranteed to be safe."

Exercise 3: Bouncing ball
Consider the bouncing ball model from Figure 2.9 on page 28. Provide an equivalent hybrid automaton model for the bouncing ball with two locations. In one location the ball should be falling down, in the other location it should be going up.
Exercise 4: State reachability
Use the rules given in Definition 8 on page 23 in the script to reason about the reachable states of the following examples.

(a) Consider the hybrid automaton from Example 9 on page 23 in the script.
   (i) Provide the set of reachable states at the time point \( t = 1.5 \).
   (ii) Provide the set of reachable states at the time point \( t = 6 \).
   (iii) Show the reachability of a state where \( x = 0 \) at the time point \( t = 1.5 \).
   (iv) Provide a run where a state with \( x = 4 \) occurs at exactly 20 time points.
       *Hint:* Describe a run \( \sigma_0 \rightarrow \sigma_1 \rightarrow \cdots \) by constraints over \( \sigma_i \).

(b) Consider the hybrid automaton from Example 10 on page 25 in the script.
   (i) Instantiate the rules Rule\textsubscript{discrete} and Rule\textsubscript{time} (as for Example 9 on page 24).
   (ii) Provide the set of reachable states at the time point \( t = 4 \).
   (iii) Show the reachability of a state with \( x = 2, y = 2 \).
       It is sufficient to show a run (no inference proof required).