Tutorial for Cyber-Physical Systems - Discrete Models
Exercise Sheet 1

General comments on our exercises

- First, try to understand the problem on your own. Then discuss the problem (resp. your solution) with your fellow students. Finally write down the solution alone or in groups of two.

- The exercises are **not optional**. You must obtain at least 50% of the exercise points. The goal is to train you to write down things in a formally correct way (being able to write down things in a formally correct way is an important goal of this lecture, and you need to train it). Correcting the exercises will help us to evaluate your knowledge and to evaluate your capability to solve the exercises in the exam.

- The mathematical background of this course's participants is very heterogeneous. Don't get frustrated if fellow students solve exercises quicker than you do.

Exercise 1: Propositional Logic   4 Points
The goal of this exercise is to train how to formulate statements as logical formulas.

Alice, Bob and Claire want to attend the CPS I lecture. The exercise groups are almost full, only group 1 and group 2 have places left.

(1) If Alice joins group 1, the tutor refuses to accept Bob because they always talk.

(2) At least one of Bob and Claire cannot go to group 1, as they lead a chess group together that meets at the same time.

(3) Claire hates Alice and doesn't want to be in the same group.

(4) Alice wants to submit the solutions with either Bob or Claire and thus needs to be in a group with this person.

Model the above statements in propositional logic where the atomic propositions a (Alice), b (Bob), c (Claire) are assigned the value `true` if the corresponding person joins group 1, and `false` else.
Which persons join which group? Use a truth table to find out.

Exercise 2: Implications 3 Points

The goal of this exercise is to familiarize yourself with different mathematical phrases.

A major problem in the development of systems is the correct wording of requirements. Often the requirements come in the form of an implication. Take the requirement *"if the battery is empty then the generator is switched on"*. This can be formulated as the implication $A \rightarrow B$ (A *implies* B) with the assertion A: "the battery is empty" and the assertion B: "the generator is switched on". There are other possible formulations of implications, but often engineers don't get it right. Hence the following exercise.

Group the following statements. Two statements should be in the same group if and only if they are equivalent.

(a) A implies B.

(b) B implies A.

(c) A is a necessary condition for B.

(d) A is a sufficient condition for B.

(e) A if B.

(f) A only if B.

(g) A is stronger than B.

(h) A is weaker than B.

(i) $A \wedge \neg B$ does not hold.

(j) $\neg A \vee B$ holds.

(k) If not B, then not A.