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**Christoph Weidenbach** **November 11, 2014**

**Tutorials for "Automated Reasoning"**
**Exercise sheet 4**

**Exercise 4.1:** (*2 P*)
Prove by induction that for any propositional formula the number of closing parenthesis is equal to the number of opening parenthesis (see Definition 2.1.1).

**Exercise 4.2:** (*4 P*)
Prove by using Definition 2.2.2 (not by truth tables, tableaux) validity of

$$\neg(\phi \lor \psi) \leftrightarrow (\neg\phi \land \neg\psi).$$

**Exercise 4.3:** (*3 P*)
The logical connective NAND (notation: $\uparrow$) is defined as: $\phi \uparrow \psi$ iff $\neg(\phi \land \psi)$. Show how the connectives $\neg$, $\land$ and $\lor$ can be equivalently rewritten using only the connective $\uparrow$. This means first, present the respective NAND formula and, second, prove it is equivalent.

**Exercise 4.4:** (*4 P*)
Prove by truth tables and tableaux, i.e., two proofs, validity of

$$(P \rightarrow (Q \rightarrow R)) \rightarrow ((P \rightarrow Q) \rightarrow (P \rightarrow R)).$$

**Exercise 4.5:** (*2 P*)
Is the following formula, valid, satisfiable, unsatisfiable?

$$(P \land Q) \ \leftrightarrow \ ((P \land R) \land (R \leftrightarrow Q))$$

Submit your solution in lecture hall E1.3, Room 002 during the lecture on November 18. Please write your name and the date of your tutorial group (Mon, Thu) on your solution.

Joint solutions are not permitted, please submit individually. However, I encourage you working and solving the exercises in a group.