

**Formal Reasoning 2014**  
**Test 1: Propositional logic**  
(16/09/14)

Before you read on, write your name, student number and study on the answer sheet!

The mark for this test is the number of points divided by ten. The first ten points are free. Good luck!

In the first three exercises we use the following interpretation of the atomic propositions:

$D$  it is day  
 $N$  it is night  
 $S$  the sun shines  
 $M$  the moon shines

1. Give two propositions that respectively resemble the meaning of the following two sentences:

(a) *Either it is day, or it is night, but when the sun shines it is not night.*

(b) *The sun only shines when it is day, but the sun doesn't shine now although it is day.*

(10 + 10 points)

2. Write the following formula according to the official grammar in the course notes, and give an English sentence that resembles the meaning of this formula as well as possible:

$$\neg D \rightarrow \neg(S \vee M) \vee M$$

(20 points)

3. The night is exactly the time of the twenty-four hours when it is not day. Does this imply that the formula

$$N \leftrightarrow \neg D$$

is logically true? Explain your answer.

(10 points)

4. Give the truth table of the formula

$$(a \rightarrow b \rightarrow c) \rightarrow (a \rightarrow b) \rightarrow (a \rightarrow c)$$

and explain how you can see in this table that this formula is logically true.

(20 points)

5. Provide a model in which the formula

$$\neg(((a \leftrightarrow \neg b \wedge \neg c) \rightarrow \neg a) \vee b) \rightarrow c$$

does not hold.

(10 points)

6. Give six formulas of the propositional logic, such that for none of these formulas it holds that it is the logical consequence of one of the other formulas. Explain your answer by writing down what 'logical consequence' means in terms of models. (10 points)