

Student Name:  
Matrikel-Nr:

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## Formale Grundlagen der Informatik I - Assignment 1

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Hand out: 21.02.2019 - Due to: 07.03.2019

Please upload your solutions to the Olat system.

### 1.1 Sets and Subsets

a) Write in your own words how to read the following sets:

- i.  $\{x \in \mathbb{R} \mid x \notin \mathbb{Q}\}$
- ii.  $\{n \in \mathbb{Z}^- \mid n > -6\}$

b) Answer the following questions with a short explanation:

- i. Is  $\emptyset \in \{\}$  ?
- ii. How many elements contains the set  $\{1, 1, 2, 2\}$  ?
- iii. How many elements contains the set  $\{0, \{0\}, \{\{0\}\}\}$  ?
- iv. Is  $2 \in \{\{1\}, \{2\}\}$  ?
- v. Is  $\{0\} \in \{\{0\}, \{1\}\}$  ?
- vi. Is  $2 \in \{\{1, 2\}\}$  ?

### 1.2 Relations and Functions

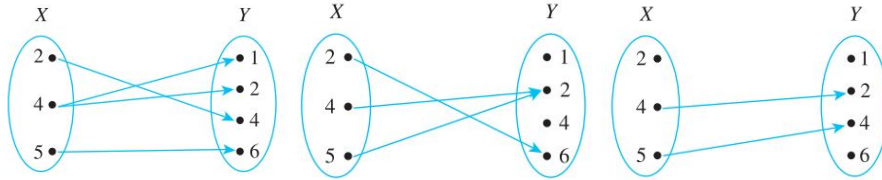
a) What is the difference between a function and a relation?

b) Let  $A = \{2, 4\}$  and  $B = \{1, 3, 5\}$ . Define the nonempty and pairwise different relations  $U, V, W \subseteq A \times B$  as follows:

- $(x, y) \in U$  implies  $x * y \geq 7$ .
- $(x, y) \in V$  implies  $x > y$ .
- $x > y$  implies  $(x, y) \in W$ .

- i. For which of the above tasks would the empty set be a valid solution (if the “non-empty” wasn’t given in the task)?
- ii. Determine if the relations  $U, V$  and  $W$  are functions and reason in a few words.

- c) Give a label for each of the following three figures. Do they show a relation, function, or something else? Please give a (short) reason for your decision?



### 1.3 Logical Equivalence

- a) Please determine (in a plausible way) which of the statement forms are tautologies and which are contradictions.

- i.  $((p \wedge \neg q \wedge \neg r) \vee (p \wedge \neg q \wedge r)) \Leftrightarrow \neg(p \vee q)$
- ii.  $(p \vee q) \vee \neg(p \wedge q)$

- b) With a few word of explanation, determine if the following statements are mutually excluding.

- Susan speaks German and English. Oliver speaks English.
- It is not the case that Oliver and Susan both speak German and English.

### 1.4 Conditional Statements

- a) Write each of the following three statements in symbolic form and determine which pairs are logically equivalent. Include a few words of explanation.

- i. If it walks like a duck and it talks like a duck, then it is a duck.
- ii. Either it does not walk like a duck or it does not talk like a duck, or it is a duck.
- iii. If it does not walk like a duck and it does not talk like a duck, then it is not a duck.

- b) The following statement is given: "If compound X is boiling, then its temperature must be at least  $150^{\circ}\text{C}$ ". Assuming that this statement is true, which of the following must also be true? Argument with respect to a necessary and sufficient condition.

- i. Compound X will boil only if its temperature is at least  $150^{\circ}\text{C}$ .
- ii. If compound X is not boiling, then its temperature is less than  $150^{\circ}\text{C}$ .
- iii. A necessary condition for compound X to boil is that its temperature be at least  $150^{\circ}\text{C}$ .

**or**

A sufficient condition for compound X to boil is that its temperature be at least  $150^{\circ}\text{C}$ .