EXAM: TDDD72 (LOGIC)

28 AUGUST 2015

RULES

1. You can use your own copies of slides as well as an English-Swedish dictionary.
2. Exercises are formulated in English, but answers can be given in English or Swedish.
3. You are not allowed to:
   - use any writing material other than indicated in point 1;
   - use calculators, mobile phones or any other electronic devices;
   - lend/borrow/exchange anything during the exam.
4. If an exercise has not been specified completely as you see it, state which (reasonable) assumptions you have made.
5. Begin each exercise on a new sheet of paper. Write only on one side of the paper. Write clearly and make sure to give adequate explanations for all your answers.
6. There are 4 exercises, each exercise gives maximum 10 points (40 points together). Grading is provided in the following table.

Number of points (n)	Grade
$34 \leq n \leq 40$	5
$27 \leq n < 34$	4
$20 \leq n < 27$	3
$n < 20$	U (not passed)

EXERCISES

EXERCISE 1

1. Prove the following propositional formula

$$[(\neg Q \to \neg(P \vee Q)) \wedge (Q \to \neg P)] \to \neg P$$

   (a) *(2 points)* using tableaux;

   (b) *(2 points)* using resolution.

2. Prove the following formula of predicate logic:

$$\exists x \exists y \exists z \Big[[(\neg P(x) \vee Q(z)) \wedge (P(y) \vee Q(x))] \to [Q(y) \vee Q(z)]\Big]$$

   (a) *(2 points)* using tableaux;

   (b) *(2 points)* using Gentzen-like system (as provided in the book or during the lectures - up to your choice);

   (c) *(2 points)* using resolution.

EXERCISE 2

1. *(4 points)* Translate the following sentences into a set of propositional formulas:

   "A given task is assigned to $robot_1$ or to $robot_2$ or to $robot_3$."
   "If the task involves driving then it is assigned to $robot_3$."
   "If the task does not involve driving then it is neither assigned to $robot_1$ nor to $robot_2$."

2. *(2 points)* Assuming a task can be assigned to exactly one robot hypothesize who is assigned the task in question and explain your reasoning informally.

3. *(4 points)* Prove your claim formally using a proof system of your choice (tableaux, Gentzen system or resolution. Please do not use truth table method, as this will give no points).

EXERCISE 3

Consider a computer network, where chosen computers are connected by cables. There might also be cables connecting computers to themselves. Cables connecting different computers are called *external* and cables connecting computers to themselves called *internal*.

Assume that $C(x, y)$ expresses the fact that there is a cable connecting computers x and y. Assume also that the following properties are satisfied:

(i) every computer is connected (internally or externally) to a computer;

(ii) relation C is symmetric;

(iii) for all computers x, y, z, whenever there is a cable connecting x to y and a cable connecting x and z then there is also a cable connecting y and z.

Please:

1. *(4 points)* express in predicate logic properties (i), (ii), (iii);
2. *(2 points)* check informally whether the conjunction of (i), (ii), (iii) implies that "every computer is connected to itself";
3. *(4 points)* verify your informal reasoning using a proof system of your choice (tableaux, Gentzen system or resolution).

EXERCISE 4

1. *(2 points)* Design a Datalog database for storing information about streets in a town. Each street is characterized by its name, width and quality (low, medium, high). In addition, for each street s the database contains information whether s is closed for traffic as well as information about all streets intersecting s.
2. *(1 point)* Express in predicate calculus the constraint stating that "every street has a unique name."
3. *(1 point)* Provide a sample integrity constraint concerning width or quality of streets.
4. Formulate in logic queries selecting:
   (a) *(2 points)* all streets of high quality or wider than 5m, intersecting street Kungsgatan;
   (b) *(4 points)* all streets accessible by car from a given street assuming that it is forbidden to drive through closed streets.