Försättsblad till skriftlig tentamen vid Linköpings universitet

Datum för tentamen	2016-01-07
Sal (2)	U11 U14
Tid	8-12
Kurskod	TDDD88
Provkod	TEN1
Kursnamn/benämning **Provnamn/benämning**	Logik En skriftlig tentamen
Institution	IDA
Antal uppgifter som ingår i tentamen	4
Jour/Kursansvarig Ange vem som besöker salen	Olov Andersson
Telefon under skrivtiden	ankn. 2069
Besöker salen ca klockan	ja
Kursadministratör/kontaktperson (namn + tfnr + mailaddress)	Anna Grabska Eklund, ankn. 2362, anna.grabska.eklund@liu.se
Tillåtna hjälpmedel	1. Student's own copies of slides from lectures 2. English-Swedish dictionary.
Övrigt	
Antal exemplar i påsen	

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EXAM: TDDD88 (LOGIC)

7 JANUARY 2015

Exam rules

1. You can use your own copies of slides from lectures as well as an English-Swedish dictionary.
2. Exercises are formulated in English, but answers can be given in English or in Swedish.
3. You are not allowed to:
   - use any writing material other than indicated in point 1, in particular you cannot use ebook with exercises and solutions;
   - 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:

$$[P \wedge (\neg Q \vee R)] \rightarrow [\neg(\neg P \wedge Q) \vee R]$$

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

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

2. Prove the following formula of first-order logic:

$$\exists x \forall y \forall z [R(x, y, z) \wedge S(x) \wedge T(y)] \rightarrow \exists x [R(x, a, b) \wedge T(a)]$$

   (a) (*3 points*) using tableaux;

   (b) (*3 points*) using resolution.

EXERCISE 2

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

   "Boxes are small or medium."
   "Each box is marked by 'S', 'G' or 'B'."
   "Small boxes are marked by 'B' or 'S'."
   "Medium boxes are marked by 'G' or 'B'."
   "For shipment robots chose boxes marked by 'S'."
   "For activities other than shipment robots chose neither boxes marked by 'B' nor by 'G'."

2. (*2 points*) Assuming that each box is marked by one of 'S', 'G', 'B', hypothesize what size of boxes can be chosen and explain your reasoning informally.

3. (*4 points*) Prove your claim formally using a proof system of your choice (tableaux or resolution.

EXERCISE 3

Consider a set of persons and a relation of "being a relative of". Let

(a) the relation *relative* has the property that whenever person A is a relative of both B and C then also B is a relative of C.

Consider the relation "the same family member", denoted by F. We assume that

(b) whenever a person A is a relative of a person B then they are in the same family;

(c) everybody is in his/her own family.

Using the provided information

(1) (*3 points*) express in predicate logic the properties (a), (b), (c)

(2) (*2 points*) assuming (a), (b), (c),

$$\forall x \forall y \forall z[(R(x,y) \wedge R(y,z)) \rightarrow R(x,z)]$$

and

$$\forall x \forall y[R(x,y) \vee \exists z[R(x,z) \wedge R(z,y)]],$$

prove informally that $\forall x \forall y[F(x,y)]$;

(3) (*5 points*) prove claim from point 2. using 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 length. 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:

   "the relation of road intersection is symmetric"

3. *(1 point)* Provide another integrity constraint concerning the relation of road intersection.

4. Formulate in logic queries selecting:

   (a) *(2 point)* all streets longer than 7km or wider than 3m, intersecting the street named "Kungsgatan";

   (b) *(4 points)* all streets accessible by car from a given street, assuming that it is impossible to drive through closed streets.