Försättsblad till skriftlig tentamen vid Linköpings universitet

Datum för tentamen	2018-04-05
Sal (1)	TER2(19)
Tid	14-19
Kurskod	TDDD72
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	013-28 20 69
Besöker salen ca klockan	ja
Kursadministratör/kontaktperson (namn + tfnr + mailaddress)	Anna Grabska Eklund, ankn. 2362, anna.grabska.eklund@liu.se
Tillåtna hjälpmedel	You can use your own copies of slides as well as an English-Swedish dictionary.
Övrigt	
Antal exemplar i påsen	

EXAM: TDDD72 (LOGIC)

5 APRIL 2018

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:

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

   (a) (*2 points*) using Gentzen system;

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

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

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

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

   (b) (*3 points*) using Gentzen system.

EXERCISE 2

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

   "When John is in a bad mood, he goes to a cinema."
   "When John is in a moderate mood, he stays at home."
   "When John is in a good mood, he visits friends."
   "John cannot be in two different moods."
   "John is in a moderate or good mood."
   "John is in a moderate or bad mood."

2. (*2 points*) Hypothesize what is John's decision where to spend time and explain your reasoning informally.

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

EXERCISE 3

Consider a relation R and properties:

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

- *(4 points)* Check informally whether the conjunction of (a) and (b) implies (c).
- *(6 points)* Verify your informal reasoning using tableaux, resolution or Gentzen system.

EXERCISE 4

1. *(2 points)* Design a Datalog database for storing information about articles in newspapers. Each article is characterized by:
   - its title
   - its length (*short, medium, long*)
   - directly related articles.
2. *(1 point)* Express in predicate calculus the constraint:

   "every article is directly related to itself."
3. *(1 point)* Provide another sample integrity constraint concerning the "directly related" relation.
4. Formulate Datalog queries selecting:
   (a) *(2 points)* all short or medium articles related to article entitled "Recursion in DBMS";
   (b) *(4 points)* all long articles directly or indirectly related to article entitled "Recursion in DBMS", assuming that articles A and B are *directly or indirectly related* when there is $k \geq 0$ and articles $A_1, \ldots, A_k$ such that:

   $$A \leftrightsquigarrow A_1 \leftrightsquigarrow \ldots \leftrightsquigarrow A_k \leftrightsquigarrow B,$$

   where $C \leftrightsquigarrow D$ denotes the fact that articles C and D are directly related.