Försättsblad till skriftlig tentamen vid Linköpings Universitet

Datum för tentamen	2014-08-27
Sal (1) Om tentan går i flera salar ska du bifoga ett försättsblad till varje sal och ringa in vilken sal som avses	TER1
Tid	8-13
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	Andrzej Szalas
Telefon under skrivtiden	013-28 19 95 eller 0709 46 1995
Besöker salen ca kl.	09:30
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 *** Kopia på egna föreläsningslides Engelsk-Svensk ordbok

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Datum för tentamen	2014-08-27
Sal (1) Om tentan går i flera salar ska du bifoga ett försättsblad till varje sal och ringa in vilken sal som avses	TER1
Tid	8-13
Kurskod	TDDC36
Provkod	TEN1
Kursnamn/benämning **Provnamn/benämning**	Logik Skriftlig tentamen
Institution	IDA
Antal uppgifter som ingår i tentamen	4
Jour/Kursansvarig Ange vem som besöker salen	Andrzej Szalas
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EXAM: TDDC36, TDDD72 (LOGIC)

27 AUGUST 2014

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)	Swedish grade	ETCS grade
$34 \leq n \leq 40$	5	A
$27 \leq n < 34$	4	B
$20 \leq n < 27$	3	C
$n < 20$	not passed	F (not passed)

EXERCISES

EXERCISE 1

1. Prove the following propositional formula:

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

   (a) (*2 points*) using tableaux

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

2. Prove the following formula of predicate logic, where a is a constant:

$$\Big[\forall x[P(x,x,x)] \wedge \neg\exists x \exists y \exists z[P(x,y,z) \wedge \neg P(z,x,a)]\Big] \rightarrow \exists z[P(a,z,a)]$$

   (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:

   "chose one of three roads: short, medium or long"
   "the short road is always crowded"
   "the medium road is not comfortable, but fast"
   "the long road is comfortable"
   "the chosen road should be comfortable."

2. (*2 points*) Assuming that fast roads are not crowded and crowded roads are not comfortable, hypothesize what roads can be chosen 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 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) $\forall x \forall y[R(x,y) \rightarrow R(y,x)]$.

1. *(4 points)* Check informally whether the conjunction of (a) and (b) implies (c).
2. *(6 points)* Verify your informal reasoning using resolution.

EXERCISE 4

1. *(2 points)* Design a Datalog database for storing information about scientific papers, containing, among others, title, authors and information about direct references between papers (i.e., for each paper, information about papers listed in its bibliography section).

   By $p \rightsquigarrow q$ we denote that paper q is among references listed in paper p.

   We define that paper q is *indirectly referenced* by paper p (and denote this by $p \twoheadrightarrow q$) if there is $k \geq 1$ and papers $p_1, p_2, \ldots, p_k$ such that

   $$p \rightsquigarrow p_1 \rightsquigarrow p_2 \rightsquigarrow \ldots \rightsquigarrow p_{k-1} \rightsquigarrow p_k \rightsquigarrow q.$$

2. *(1 point)* Provide an exemplary integrity constraint concerning $\rightsquigarrow$.
3. *(1 point)* Provide an exemplary integrity constraint concerning $\twoheadrightarrow$.
4. Formulate in logic queries selecting:
   (a) *(2 points)* all pairs $P1, P2$ of papers both (co-)authored by 'John Smith' such that $P1 \rightsquigarrow P2$
   (b) *(4 points)* all pairs $P1, P2$ of papers both (co-)authored by 'John Smith' such that $P1 \twoheadrightarrow P2$.