Försättsblad till skriftlig tentamen vid Linköpings Universitet

Datum för tentamen	2014-04-24
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	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	Andrzej Szalas
Telefon under skrivtiden	013-28 19 95 eller 0709 46 1995
Besöker salen ca kl.	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 *** Kopia på egna föreläsningslides Engelsk-Svensk ordbok
Övrigt	
Vilken typ av papper ska användas, rutigt eller linjerat	Valfritt
Antal exemplar i påsen	

EXAM: TDDC36, TDDD72 (LOGIC)

24 APRIL 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:

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

   (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:

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

   (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:

   "objects are light, medium or heavy"
   "one can pack light objects to the first truck, medium objects to the second truck and heavy objects to the third truck"
   "light objects are green"
   "medium objects are blue"
   "heavy objects are red"
   "pack objects to the second or to the third truck"
   "do not pack red objects".

2. (*2 points*) Assuming that each object can be packed to at most one truck, hypothesize what choice as to object's weight can be made 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 drawing which consists of lines connecting points and satisfying the following conditions:

(a) "Every point is connected to a point."
(b) "Connection is symmetric."
(c) "For every points x, y, z, if there is a connection between x and y and between x and z then there is also a connection between y and z."

1. (*2 points*) Express in predicate logic properties (a), (b) and (c).
2. (*4 points*) Check informally whether the conjunction of (a), (b) and (c) implies that "every point is connected to itself".
3. (*5 points*) Verify your informal reasoning using resolution.

EXERCISE 4

1. *(2 points)* Design a Datalog database for storing information about employees (including position and salary) as well as information about the *direct supervisor* relationship among employees.

   By $e' \rightsquigarrow e''$ we denote that e' is a direct supervisor of e''.

   We define that employee e' is an *indirect supervisor* of employee e'' if there is $k \geq 1$ and employees $e_1, e_2, \ldots, e_k$ such that

   $$e' \rightsquigarrow e_1 \rightsquigarrow e_2 \rightsquigarrow \ldots \rightsquigarrow e_{k-1} \rightsquigarrow e_k \rightsquigarrow e''.$$

2. *(1 point)* Express in predicate calculus the constraint:

   "the relationship of being an indirect supervisor is transitive."

3. *(1 point)* Provide an exemplary integrity constraint concerning direct supervisor relationship.

4. Formulate in logic queries selecting:

   (a) *(2 points)* all pairs of employees consisting of executive officers with one being a direct supervisor of another;

   (b) *(4 points)* all pairs of employees X, Y such that the X is a direct or indirect supervisor of Y and X has a lower salary than Y.