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Försättsblad till skriftlig tentamen vid Linköpings universitet

Datum för tentamen	2015-04-09
Sal (1)	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	Olof 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 AND TDDC36 (LOGIC)

9 APRIL 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 tables below.

number of points	Swedish grade	ETCS grade
34 — 40	5	A
27 — 33	4	B
20 — 26	3	C
0 — 19	not passed	F (not passed)

EXERCISES

EXERCISE 1

1. Prove the following propositional formula:[1]

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

   (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:

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

   (a) *(3 points)* using 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 red, green or blue."
   "Small boxes are blue or red."
   "Medium boxes are green or blue."
   "For shipment robots do chose red boxes."
   "For activities other than shipment robots chose neither blue nor green boxes."

2. *(2 points)* Assuming that exactly one box is to be chosen hypothesize what choice (size and color) 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).

[1] Recall that there is precedence among the connectives. The order of precedence from high to low is: negation, conjunction, disjunction, implication, equivalence. For example, $\neg Q \vee S \wedge R$ stands for $(\neg Q) \vee (S \wedge R)$.

EXERCISE 3

Consider a building, where rooms are (or are not) connected by corridors. There might also be corridors connecting rooms to themselves. Corridors connecting different rooms are called *useful* and those connecting a room to itself are called *redundant*.

Assume that $C(x, y)$ expresses the fact that rooms x and y are connected by a corridor.[2] Assume also that the following properties are satisfied:

(i) relation C is serial;

(ii) relation C is symmetric;

(iii) for all rooms x, y, z, whenever there is a corridor between x and y and between x and z then there is also a corridor between y and z.

Please:

1. *(3 points)* express in predicate logic properties (i), (ii), (iii);
2. *(2 points)* check informally whether the conjunctio=n of (i), (ii), (iii) implies that "every room is connected (by a redundant corridor) to itself";
3. *(5 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 sizes of objects in a given area ("small", "medium", "large") and relationships between these objects, including information whether two given objects are directly connected.

   Object o' is indirectly connected to object o'' if there is $k \geq 1$ and objects $o_1, o_2, \ldots, o_k$ such that o' is connected to o_1, o_1 is connected to $o_2, \ldots$, o_{k-1} is connected to o_k and o_k is connected to o''.
2. *(1 point)* Express in predicate calculus the constraint:

   > "the relationship of being directly connected is symmetric and not transitive."
3. *(1 point)* Provide an exemplary integrity constraint concerning "connected".
4. Formulate in logic queries selecting:
   (a) *(2 point)* all pairs of objects consisting of not small objects connected to each other;
   (b) *(4 points)* all pairs of large objects connected directly or indirectly to each other.

[2]Note that $C(x, x)$ means that there is a redundant corridor connecting x to itself.