S

Försättsblad till skriftlig tentamen vid Linköpings Universitet

Datum för tentamen	2015-01-16
Sal (1)	U1
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 klockan	ja
Kursadministratör/kontaktperson (namn + tfnr + mailaddress)	Anna Grabska Eklund, ankn. 2362, anna.grabska.eklund@liu.se
Tillåtna hjälpmedel	1You 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.
Övrigt	
Antal exemplar i påsen	

EXAM: TDDD72 AND TDDC36 (LOGIC)

16 JANUARY 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 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

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

   (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:

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

   (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:

   "Take an umbrella or wear a raincoat or stay at home."
   "If it rains then wear a raincoat."
   "If it does not rain then neither stay at home nor take an umbrella."

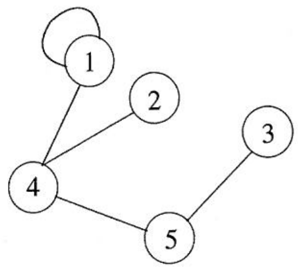
2. (*2 points*) Do the above sentences imply "wear a raincoat"? Explain your reasoning informally.

3. (*4 points*) Prove your claim formally using a proof system of your choice (tableaux, Gentzen system or resolution).[1]

[1]Please do not use truth table method, as this will give no points.

EXERCISE 3

Consider games, in which two players put stones on places. Some places are connected and some are not (see, e.g., figure below, where 3 and 5 are connected, place 1 is connected to itself and to 4, place 3 is not connected to 4, places 2, 3, 4, 5 are not connected to themselves, etc.).



There are three rules:

(i) If a place A contains a stone of player P then no place connected to A can contain a stone of P.

(ii) Any place can contain at most one stone.

(iii) Player P looses if there is no place to put his/her stone.

Assume that three relation symbols are available: $P(x)$ meaning that the place x contains a stone of player P, $Q(x)$ meaning that the place x contains a stone of player Q and $C(x, y)$ meaning that places x and y are connected. Observe that:

(a) For every places x, y, if x is connected to y then y is connected to x.

Different games are obtained by drawing different connections between places. A particular game can, for example, satisfy the following conditions:

(b) Every place is connected to at least one place.
(c) For every places x, y, z, if x is connected to y and to z then y is connected to z.

1. *(3 points)* Express rules (i), (ii), (iii) and properties (a), (b), (c) as formulas of predicate logic.

2. *(3 points)*

   (*) Check informally whether the conjunction of (a), (b), (c) implies that "every place is connected to itself".

   (**) From that property and rules of the game deduce that in such a case no move is possible.

3. *(4 points)* Verify your informal reasoning concerning (*) 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 scientific books, containing, among others, information about authors, scientific area (e.g., mathematics, computer science, chemistry, etc.), publisher, publishing year and direct references between books (i.e., information about books listed in the bibliography list of a given book).

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

   > "every book has a unique publishing year and is associated with at least one scientific area."

3. *(1 point)* Provide an exemplary integrity constraint concerning the publisher.

4. Formulate in logic queries selecting:

   (a) *(2 points)* a query selecting all books published after year 2013 and containing references to a book (co-)authored by a given author;

   (b) *(4 points)* all books published by a given publisher not earlier than in year 2011, referenced directly or indirectly by a given book.[2]

[2] E.g., if the book "Databases" references the book "Operating systems" and "Operating systems" references "Networking" then "Databases" directly references "Operating systems" and indirectly references "Networking", etc. That is, we assume that indirect references are transitive.