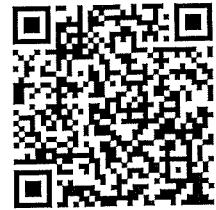


1079

Försättsblad till skriftlig tentamen vid Linköpings universitet



Datum för tentamen	2018-08-31
Sal (1)	<u>TER3(13)</u>
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	You can use your own copies of slides as well as an English-Swedish dictionary.
Övrigt	
Antal exemplar i påsen	

EXAM: TDDD72 (LOGIC)

31 AUGUST 2018

Exam rules

1. You can use your own copies of compendium (extract from slides) 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 full slides nor the ebook with exercises and solutions;
 - use calculators, mobile phones nor 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). The exam will be graded according to 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:

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

- (a) (2 points) using tableaux;
- (b) (2 points) using Gentzen system.

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

$$\forall x \exists y \forall z (P(x, y, z) \vee P(z, y, x)) \rightarrow \forall x \exists y \exists z (P(x, y, z) \vee P(z, y, x))$$

- (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:

“Each object is marked by one of symbols: Δ , \bigcirc , \square .”

“Objects marked by Δ are red.”

“Objects marked by \bigcirc are green.”

“Objects marked by \square are blue.”

“Chose an object being green or not being red.”

“Chose an object being blue or not being green.”

2. (2 points) Assuming that exactly one object is to be chosen, hypothesize what choice as to the object's color can be made and explain your reasoning informally.
3. (4 points) Prove your claim formally using proof system of your choice (tableaux or resolution).

EXERCISE 3

Consider a relation R and properties:

- (a) $\forall x \forall y \forall z [(R(x, y) \wedge R(y, z)) \rightarrow R(z, y)];$
- (b) $\forall x \forall y [R(x, y) \rightarrow \exists z [R(z, x)]];$
- (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 resolution or Gentzen system.

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

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

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

“every employee, excluding the president of the board, has a direct supervisor.”
3. (1 point) Provide an integrity constraint concerning the indirect supervisor relationship.
4. Formulate in logic queries selecting:
 - (a) (2 points) all pairs of employees consisting of software developers 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 .