Försättsblad till skriftlig tentamen vid Linköpings universitet

Datum för tentamen	2015-10-28
Sal (2)	TER2 TER3
Tid	8-12
Kurskod	TDDD88
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	Tommy Persson
Telefon under skrivtiden	ankn. 4497
Besöker salen ca klockan	ja mellan 09:30-10
Kursadministratör/kontaktperson (namn + tfnr + mailaddress)	Anna Grabska Eklund, ankn. 2362, anna.grabska.eklund@liu.se
Tillåtna hjälpmedel	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.
Övrigt	
Antal exemplar i påsen	

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EXAM: TDDD88 (LOGIC)

28 OCTOBER 2015

Exam rules

1. You can use your own copies of slides from lectures 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 ebook with exercises and solutions;
   - 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)	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:

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

   (a) (*2 points*) using tableaux;

   (b) (*2 points*) using resolution.

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

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

   (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, where 'Co Ltd' is a company:

   " If 'Co Ltd' will not offer a new product then it will take a loan or will have cash flow problems."
   " If 'Co Ltd' will take a loan and its income will decrease then it will offer a new product."
   " If the income of 'Co Ltd' will not decrease then 'Co Ltd' will offer a new product or will have cash flow problems."
   " If 'Co Ltd' will have cash flow problems then it will offer a new product."

2. (*2 points*) Check informally whether sentences expressed in point 1 imply that 'Co Ltd' will offer a new product.

3. (*4 points*) Prove your claim formally using either tableaux or resolution.

EXERCISE 3

Consider relation $BE(x, y)$ among choices, intuitively meaning that choice x is better than or equal to choice y.

(1) (*1 point*) Express in first-order logic the property that there is the worst choice (i.e., the choice which is worse than or equal to any choice);

(2) (*3 points*) assuming that there is the worst choice together with symmetry and transitivity of BE, prove informally that BE is reflexive;

(3) (*6 points*) prove (2) formally, using resolution or tableaux.

Recall that relation BE is:

- reflexive, if $\forall x[BE(x, x)]$;
- symmetric, if $\forall x \forall y[BE(x, y) \rightarrow BE(y, x)]$;
- transitive, if $\forall x \forall y \forall z[(BE(x, y) \wedge BE(y, z)) \rightarrow BE(x, z)]$.

EXERCISE 4

1. *(2 points)* Design a Datalog database for storing information about situations. Each situation is characterized by its safety level (low, medium or high) and duration (short, medium, long). In addition the database should contain information about possible direct continuations of situations. For example, if a given situation s has direct continuations s_1 and s_2 then each of situations s_1, s_2 can occur immediately after s.

   A situation s' is an indirect continuation of situation s if there is $k \geq 1$ and situations $s_1, s_2, \ldots, s_k$ such that:

   - s_1 is a direct continuation of s;
   - s_2 is a direct continuation of s_1;
   - ...
   - s_k is a direct continuation of s_{k-1};
   - s' is a direct continuation of s_k.

2. *(1 point)* Express in first-order logic the constraint:

   "a situation has a unique safety level and duration."

3. *(1 point)* Provide a sample integrity constraint concerning direct continuation among situations.

4. Formulate Datalog queries selecting:

   (a) *(2 points)* all pairs of situations s, s' such that s is a situation with short or medium duration and s' is its direct continuation with long duration and safety level medium or high;

   (b) *(4 points)* all situations s with short or medium duration, having a direct or indirect continuation with low safety level.