Tik-79.146 **Kevät 2000**
Logiikka tietotekniikassa: erityiskysymyksiä I
Laskuharjoitus 7
Ratkaisut

1. a)

1.	$\langle 1\rangle\neg\big(\Box P \to \Box(Q \to P)\big)$	
2.	$\langle 1\rangle\Box P$	(1)
3.	$\langle 1\rangle\neg\Box(Q \to P)$	(1)
4.	$\langle 1,2\rangle\neg(Q \to P)$	(3)
5.	$\langle 1,2\rangle Q$	(4)
6.	$\langle 1,2\rangle\neg P$	(4)
7.	$\langle 1,2\rangle P$	(2)
	$\otimes$	

b)

1.	$\langle 1\rangle\neg\big(\Box(P \to Q) \to (\neg\Box\neg P \to \neg\Box\neg Q)\big)$	
2.	$\langle 1\rangle\Box(P \to Q)$	(1)
3.	$\langle 1\rangle\neg(\neg\Box\neg P \to \neg\Box\neg Q)$	(1)
4.	$\langle 1\rangle\neg\Box\neg P$	(3)
5.	$\langle 1\rangle\neg\neg\Box\neg Q$	(3)
6.	$\langle 1\rangle\Box\neg Q$	(5)
7.	$\langle 1,2\rangle\neg\neg P$	(4)
8.	$\langle 1,2\rangle P$	(7)
9.	$\langle 1,2\rangle\neg Q$	(6)
10.	$\langle 1,2\rangle(P \to Q)$	(2)
11.	$\langle 1,2\rangle\neg P$ (10) $\otimes$	12. $\langle 1,2\rangle Q$ (10) $\otimes$

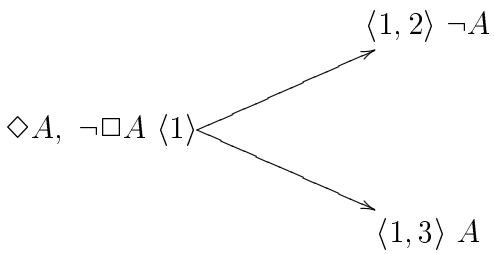
c)

1.	$\langle 1\rangle\neg\big((\Box P \wedge \Box Q) \to \Box(P \wedge Q)\big)$	
2.	$\langle 1\rangle\Box P \wedge \Box Q$	(1)
3.	$\langle 1\rangle\neg\Box(P \wedge Q)$	(1)
4.	$\langle 1\rangle\Box P$	(2)
5.	$\langle 1\rangle\Box Q$	(2)
6.	$\langle 1,2\rangle\neg(P \wedge Q)$	(3)
7.	$\langle 1,2\rangle P$	(4)
8.	$\langle 1,2\rangle Q$	(5)
9.	$\langle 1,2\rangle\neg P$ (6) $\otimes$	10. $\langle 1,2\rangle\neg Q$ (6) $\otimes$

2. a)

1.	$\langle 1\rangle\neg(\Diamond A \to \Box A)$	
2.	$\langle 1\rangle\Diamond A$	(1)
3.	$\langle 1\rangle\neg\Box A$	(1)
4.	$\langle 1\rangle\neg\Box\neg A$	(2)
5.	$\langle 1,2\rangle\neg A$	(3)
6.	$\langle 1,3\rangle\neg\neg A$	(4)
7.	$\langle 1,3\rangle A$	(6)

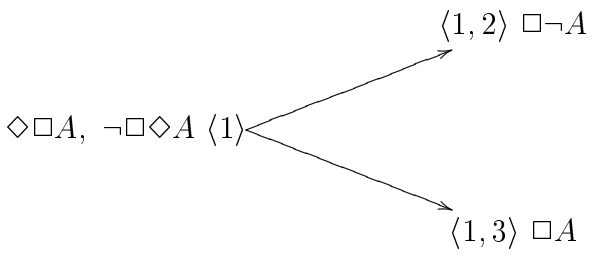
Ei **K**-pätevä.



b)

1.	$\langle 1\rangle\neg(\Diamond\Box A \to \Box\Diamond A)$	
2.	$\langle 1\rangle\Diamond\Box A$	(1)
3.	$\langle 1\rangle\neg\Box\Diamond A$	(1)
4.	$\langle 1\rangle\neg\Box\neg\Box A$	(2)
5.	$\langle 1,2\rangle\neg\Diamond A$	(3)
6.	$\langle 1,3\rangle\neg\neg\Box A$	(4)
7.	$\langle 1,2\rangle\neg\neg\Box\neg A$	(5)
8.	$\langle 1,3\rangle\Box A$	(6)
9.	$\langle 1,2\rangle\Box\neg A$	(7)

Ei **K**-pätevä.

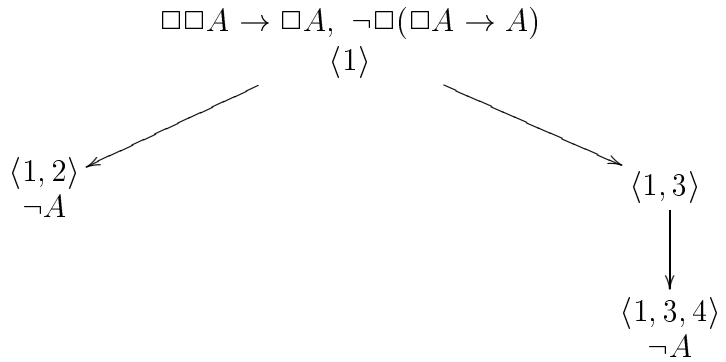


c)

1.	$\langle 1\rangle\neg(\Box\Box A \to \Box\Box\Box A)$	
2.	$\langle 1\rangle\Box\Box A$	(1)
3.	$\langle 1\rangle\neg\Box\Box\Box A$	(1)
4.	$\langle 1,2\rangle\neg\Box\Box A$	(3)
5.	$\langle 1,2\rangle\Box A$	(2)
6.	$\langle 1,2,3\rangle\neg\Box A$	(4)
7.	$\langle 1,2,3\rangle A$	(5)
8.	$\langle 1,2,3,4\rangle\neg A$	(6)

Ei **K**-pätevä. $\langle 1\rangle \longrightarrow \langle 1,2\rangle \longrightarrow \begin{matrix} A \\ \langle 1,2,3\rangle \end{matrix} \longrightarrow \begin{matrix} \neg A \\ \langle 1,2,3,4\rangle \end{matrix}$

d)

1.	$\langle 1\rangle\neg((\Box\Box A \to \Box A) \to \Box(\Box A \to A))$				
2.	$\langle 1\rangle\Box\Box A \to \Box A$	(1)			
3.	$\langle 1\rangle\neg\Box(\Box A \to A)$	(1)			
4.	$\langle 1\rangle\neg\Box\Box A$	(2)	5.	$\langle 1\rangle\Box A$	(2)
6.	$\langle 1,2\rangle\neg(\Box A \to A)$	(3)	7.	$\langle 1,2\rangle\neg(\Box A \to A)$	(3)
8.	$\langle 1,3\rangle\neg\Box A$	(4)	12.	$\langle 1,2\rangle\Box A$	(7)
9.	$\langle 1,2\rangle\Box A$	(6)	13.	$\langle 1,2\rangle\neg A$	(7)
10.	$\langle 1,2\rangle\neg A$	(6)	14.	$\langle 1,2\rangle A$	(5)
11.	$\langle 1,3,4\rangle\neg A$	(8)		$\otimes$	

Ei **K**-pätevä.