

1.

(a)

$$(i) f \leftrightarrow a' \equiv (f \rightarrow a')(f' \rightarrow a) \equiv (f' + a')(f + a).$$

$$(ii) f \leftrightarrow a \wedge b' \equiv (f \rightarrow a)(f \rightarrow b')(f' \rightarrow a' \vee b) \equiv (f' + a)(f' + b')(f + a' + b).$$

$$(iii) f \leftrightarrow a \wedge b' \equiv (f \rightarrow a)(f' \rightarrow b)(f \rightarrow a' \vee b') \equiv (f + a)(f + b)(f' + a' + b')$$

$$(iv) f \leftrightarrow a \vee b \equiv f' \leftrightarrow a' \wedge b' \equiv (f' \rightarrow a')(f' \rightarrow b')(f \rightarrow a \vee b) \\ \equiv (f + a')(f + b')(f' + a + b).$$

$$(v) f \leftrightarrow (a \vee b)' \equiv f \leftrightarrow a' \wedge b' \equiv (f \rightarrow a')(f \rightarrow b')(f' \rightarrow a \vee b) \\ \equiv (f' + a')(f' + b')(f + a + b).$$

(b)

$$\begin{cases} 19 \times 3 + 1 + 1 + 1 = 60 \text{ clause} \\ 19 \times 7 + 3 + 3 + 1 = 140 \text{ literal.} \end{cases}$$

(g<sub>23</sub>)

$$(g_{23} + g_{22}') (g_{23} + g_{21}') (g_{23}' + g_{22} + g_{21})$$

$$(g_{21} + g_{20}') (g_{21}' + g_{20}) (g_{21} + g_{20}' + g_{19})$$

$$(g_{20} + g_{19}') (g_{20}' + g_{19}) (g_{20} + g_{19}' + g_{18})$$

$$(g_{18} + g_{17}') (g_{18}' + g_{17}) (g_{18} + g_{17}' + g_{16})$$

$$(g_{16} + g_{15}') (g_{16}' + g_{15}) (g_{16} + g_{15}' + g_{14})$$

$$(g_{14} + g_{13}') (g_{14}' + g_{13}) (g_{14} + g_{13}' + g_{12})$$

$$(g_{12} + g_{11}') (g_{12}' + g_{11}) (g_{12} + g_{11}' + g_{10})$$

$$(g_{10} + g_{9}') (g_{10}' + g_9) (g_{10} + g_9' + g_8)$$

$$(g_8 + g_7') (g_8' + g_7) (g_8 + g_7' + g_6)$$

$$(g_6 + g_5') (g_6' + g_5) (g_6 + g_5' + g_4)$$

$$(g_4 + g_3') (g_4' + g_3) (g_4 + g_3' + g_2)$$

$$(g_2 + g_1') (g_2' + g_1) (g_2 + g_1' + g_0)$$

$$(g_0 + g_{-1}') (g_0' + g_{-1}) (g_0 + g_{-1}' + g_{-2})$$

$$(g_{-2} + g_{-3}') (g_{-2}' + g_{-3}) (g_{-2} + g_{-3}' + g_{-4})$$

$$(g_{-4} + g_{-5}') (g_{-4}' + g_{-5}) (g_{-4} + g_{-5}' + g_{-6})$$

(c)

$$\begin{cases} 44 \text{ clause} \downarrow 26.67\% \\ 100 \text{ literal} \downarrow 28.57\% \end{cases}$$

(g<sub>23</sub>)

$$(g_{23} + g_{22} + g_{21})$$

$$(g_{22}' + g_{20}) (g_{22}' + g_{19})$$

$$(g_{21}' + g_{20}') (g_{21}' + g_{19}')$$

$$(g_{20} + g_{19}') (g_{20} + g_{18}) (g_{20} + g_{19}' + g_{17})$$

$$(g_{18} + g_{17}') (g_{18}' + g_{17}) (g_{18} + g_{17}' + g_{16})$$

$$(g_{16} + g_{15}') (g_{16}' + g_{15}) (g_{16} + g_{15}' + g_{14})$$

$$(g_{14} + g_{13}') (g_{14}' + g_{13}) (g_{14} + g_{13}' + g_{12})$$

$$(g_{12} + g_{11}') (g_{12}' + g_{11}) (g_{12} + g_{11}' + g_{10})$$

$$(g_{10} + g_9') (g_{10}' + g_9) (g_{10} + g_9' + g_8)$$

$$(g_8 + g_7') (g_8' + g_7) (g_8 + g_7' + g_6)$$

$$(g_6 + g_5') (g_6' + g_5) (g_6 + g_5' + g_4)$$

$$(g_4 + g_3') (g_4' + g_3) (g_4 + g_3' + g_2)$$

$$(g_2 + g_1') (g_2' + g_1) (g_2 + g_1' + g_0)$$

$$(g_0 + g_{-1}') (g_0' + g_{-1}) (g_0 + g_{-1}' + g_{-2})$$

$$(g_{-2} + g_{-3}') (g_{-2}' + g_{-3}) (g_{-2} + g_{-3}' + g_{-4})$$

$$(g_{-4} + g_{-5}') (g_{-4}' + g_{-5}) (g_{-4} + g_{-5}' + g_{-6})$$

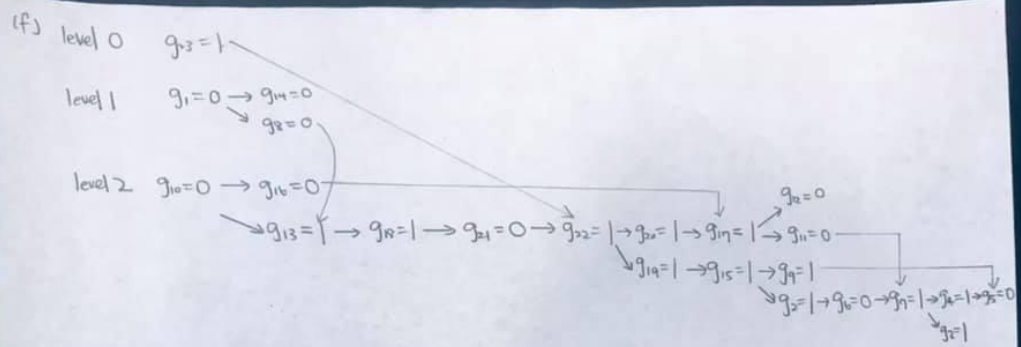
(d)

$g_{23}$	(1, 1)	$g_{13}$	(1, 1)	$g_3$	(2, 3)
$g_{22}$	(2, 1)	$g_{12}$	(3, 2)	$g_2$	(2, 3)
$g_{21}$	(2, 1)	$g_{11}$	(4, 2)	$g_1$	(2, 5)
$g_{20}$	(2, 3)	$g_{10}$	(4, 4)		
$g_{19}$	(1, 1)	$g_9$	(1, 1)		
$g_{18}$	(1, 2)	$g_8$	(2, 1)		
$g_{17}$	(3, 2)	$g_7$	(4, 3)		
$g_{16}$	(3, 2)	$g_6$	(4, 3)		
$g_{15}$	(3, 1)	$g_5$	(1, 1)		
$g_{14}$	(3, 1)	$g_4$	(3, 2)		

(e)

score=5	$g_1 = 0$
score=4	$g_{10} = 0 \rightarrow g_7 = 1 \rightarrow g_6 = 1 \rightarrow g_{11} = 1$
score=3	$g_{20} = 0 \rightarrow g_{17} = 1$

(f) Next Page.



$g_7, g_6, g_{11}, g_{20}, g_7$  have implicated, finish!!

1) Implicated value (witness):  $g_1 = 0, g_2 = 1, g_3 = 1, g_4 = 1$