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Homework 2

1)

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A	B	0	1	A AND 0	A + 1	A + (A AND B)	A + ((~A) AND B)	A + B
0	0	0	1	0	1	0	0	0
0	1	0	1	0	1	0	1	1
1	0	0	1	0	1	1	1	1
1	1	0	1	0	1	1	1	1

As can be seen from the truth table, $A \text{ AND } 0 = 0$, $A + 1 = 1$, $A + (A \text{ AND } B) = A$, $A + ((\sim A) \text{ AND } B) = A + B$

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2)

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A	B	f0	f1	f2	f3	f4	f5	f6	f7	f8	f9	fa	fb	fc	fd	fe	ff
0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
0	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
1	0	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
1	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1

f_9	$\sim A$	$\sim B$	AB	$(\sim A)(\sim B) + AB$
1	1	1	0	1
0	1	0	0	0
0	0	1	0	0
1	0	0	1	1

Therefore, $f_9 = (\sim A)(\sim B) + AB$

✓

f_6	$A(\sim B)$	$(\sim A)B$	$A(\sim B) + (\sim A)B$
0	0	0	0
1	0	1	1
1	1	0	1
0	0	0	0

Therefore, $f_6 = A(\sim B) + (\sim A)B$ ✓

f_2	$A(\sim B)$
0	0
0	0
1	1
0	0

Therefore, $f_2 = A(\sim B)$ ✓

3)

A	B	Carry In	Sum	Carry Out
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

A	B	Carry In	Sum	$(\sim A)(\sim B)$ CarryIn	$(\sim A)(B)$ $(\sim \text{CarryIn})$	$A(\sim B)$ $(\sim \text{CarryIn})$	AB CarryIn	$(\sim A)(\sim B)\text{CarryIn} +$ $(\sim A)(B)(\sim \text{CarryIn}) +$ $A(\sim B)(\sim \text{CarryIn}) +$ $ABC\text{CarryIn}$
0	0	0	0	0	0	0	0	0
0	0	1	1	1	0	0	0	1
0	1	0	1	0	1	0	0	1
0	1	1	0	0	0	0	0	0
1	0	0	1	0	0	1	0	1
1	0	1	0	0	0	0	0	0
1	1	0	0	0	0	0	0	0
1	1	1	1	0	0	0	1	1

Therefore, Sum = $(\sim A)(\sim B)\text{CarryIn} + (\sim A)(B)(\sim \text{CarryIn}) + A(\sim B)(\sim \text{CarryIn}) + ABC\text{CarryIn}$

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A	B	Carry In	Carry Out	(~A)(B) CarryIn	A(~B) CarryIn	AB (~CarryIn)	AB CarryIn	(~A)(B)CarryIn + A(~B)CarryIn + AB(~CarryIn) + ABCarryIn
0	0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	1	1	1	1	0	0	0	1
1	0	0	0	0	0	0	0	0
1	0	1	1	0	1	0	0	1
1	1	0	1	0	0	1	0	1
1	1	1	1	0	0	0	1	1

Therefore, CarryOut = (~A)(B)CarryIn + A(~B)CarryIn + AB(~CarryIn) + ABCarryIn

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By manipulation of the last Boolean expression, show that:

$$\text{CarryOut} = ab + a\text{CarryIn} + b\text{CarryIn}$$

Starting with:

$$\text{CarryOut} = (\sim A)(B)\text{CarryIn} + (A)(\sim B)\text{CarryIn} + AB(\sim \text{CarryIn}) + ABCarryIn$$

$$\text{CarryOut} = (\sim A)(B)\text{CarryIn} + (A)(\sim B)\text{CarryIn} + AB(\sim \text{CarryIn}) + ABCarryIn + ABCarryIn + ABCarryIn$$

$$\text{CarryOut} = (\sim A)(B)\text{CarryIn} + ABCarryIn + (A)(\sim B)\text{CarryIn} + ABCarryIn + AB(\sim \text{CarryIn}) + ABCarryIn$$

$$\text{CarryOut} = B\text{CarryIn}(A + (\sim A)) + A\text{CarryIn}(B + (\sim B)) + AB(\text{CarryIn} + (\sim \text{CarryIn}))$$

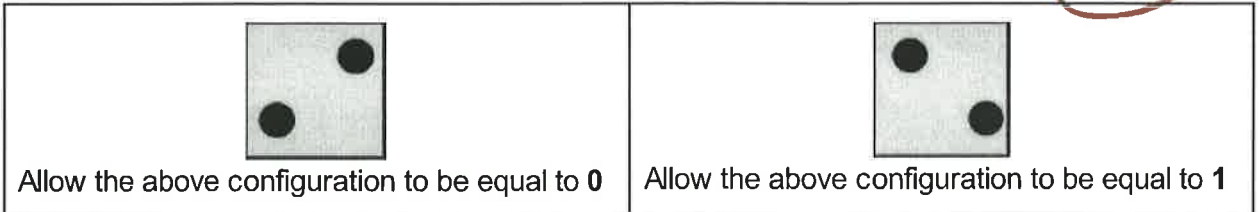
$$\text{CarryOut} = B\text{CarryIn}(1) + A\text{CarryIn}(1) + AB(1)$$

$$\text{CarryOut} = AB + A\text{CarryIn} + B\text{CarryIn}$$

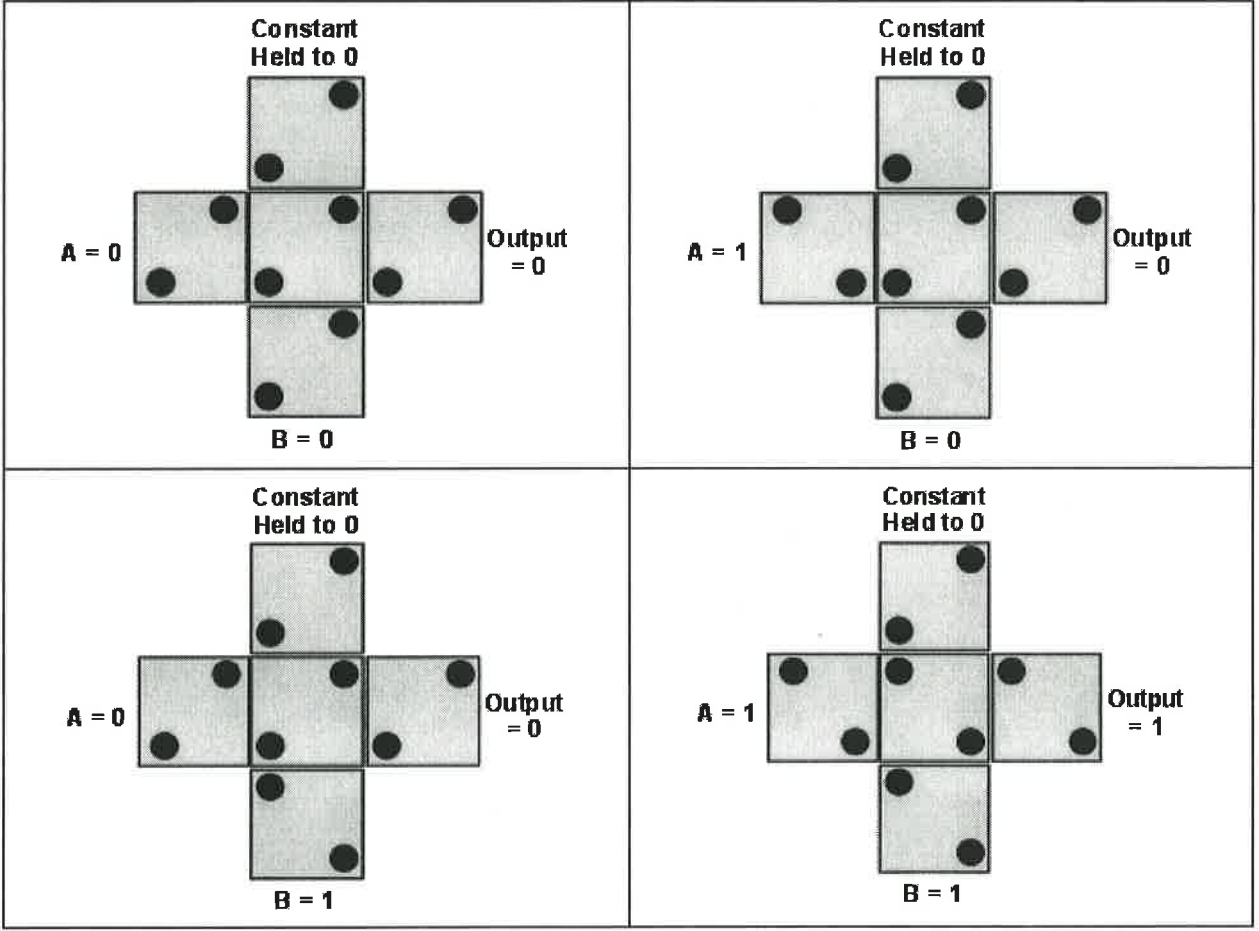
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4)



Below are the 4 possible configurations of the AND gate using the majority voting architecture:



This produces the following AND truth table:

Input A	Input B	Output
0	0	0
0	1	0
1	0	0
1	1	1