LE4.5

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LE4.5.1: 2-input functions

4/4 points (ungraded)

Consider the 2×2 K-map needed to hold the truth table for a 2-input Boolean function.

If the truth table for the 2-input function contained only a single "1" in the output column, what is the maximum number of prime implicants that could be circled in the corresponding K-map?

Maximum number of prime-implicants: 1 ✓

If the truth table for the 2-input function contained exactly two "1s" in the output column, what is the maximum number of prime implicants that could be circled in the corresponding K-map?

Maximum number of prime-implicants: 2 ✓

If the truth table for the 2-input function contained exactly three "1s" in the output column, what is the maximum number of prime implicants that could be circled in the corresponding K-map?

Maximum number of prime-implicants: 2 ✓

If you only had a supply of 2-input NAND gates to build a circuit, what is the *minimum* number of 2-input NANDs you would need to implement any arbitrary 2-input Boolean function? Hint: think about your answers to the questions above and what they imply about a minimal sum-of-products expression for an arbitrary 2-input function. Then think about how to implement a sum-of-products circuits using only NANDs.

Minimum number of 2-input NANDs needed: 5 ✓

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LE4.5.2: Minimal Sum Of Products

2/3 points (ungraded)

The 3-input boolean function $G(A, B, C)$ computes $\overline{A} \cdot \overline{C} + A \cdot \overline{B} + \overline{B} \cdot \overline{C}$.

A) How many 1's are there in the output column of G's 8-row truth table?

- (●) 3
- ( ) 4 ✓
- ( ) 5
- ( ) 6
- ( ) none of the above

✗

Explanation

The easiest way to tell is to build the truth table:

A	B	C	G(A,B,C)
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	1

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1	0	1	1
1	1	0	0
1	1	1	0

B) A minimal sum-of-products expression for G is:

- ( ) $A \cdot \overline{B} \cdot C + \overline{A}$
- ( ) $A \cdot B \cdot C + A \cdot \overline{B} \cdot \overline{C}$
- (•) $A \cdot \overline{B} + \overline{A} \cdot \overline{C}$
- ( ) $\overline{A} \cdot \overline{C} + \overline{B} \cdot \overline{C}$
- ( ) all of the above
- ( ) none of the above

✔

Explanation
To solve this problem we can use the method of Karnaugh Maps. The Karnaugh Map for this problem is:

C \ AB	**00**	**01**	**11**	**10**
0	1	1	0	1
1	0	0	0	1

Note the order of the AB transition from 01 to 11 and then to 10. We want to make sure that the Hamming Distance between adjacent cells is only 1. We then find the largest groupings of size power of 2 that cover all of the one's with either a square or a rectangle (including ones that traverse the edges of the karnaugh map like a torus). The top two left ones are merged into the term $\overline{A} \cdot \overline{C}$, and the two 1's in the rightmost column are merged into the term $A \cdot \overline{B}$.

C) There's good news and bad news: the bad news is that the stockroom only has G gates. The good news is that it has as many as you need. Using only combinational circuits built from G gates, one can implement

- (•) any function (G is universal)
- ( ) only functions with 3 inputs or less
- ( ) only functions with the same truth table as G
- ( ) only inverting functions
- ( ) only non-inverting functions

✔

Explanation
If you set C = 0, then G reduces to a NAND gate because G(A, B, 0) = NAND(A, B). Since NAND gates are universal that means that G is also universal.

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Answers are displayed within the problem

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- question and answer are misconducts — 2
  the question asks for the minimum number of 2 input nand and the answer is we need at most 5 2-input nand ! i can make an expression f...
- Minimum number of 2-input NANDs needed? — 2
  I think the minimum number of NANDs is 9. As to a 2-input Boolean function, say f(A,B), then f(A,B) = not(A)*not(B) + AB would cost the la...
- G(A,B,0) == Nand ? — 2
  I can see that if I only take the terms where C=0 in the Truth table of G ⟶ We get NAND's truth table. How can I simplify **G = ~C.~A ...
- Why just A.~B+~A.~C? — 2
  For part B of question LE4.5.2, could someone explain to me why the answer is just A.~B+~A.~C but not A.~B+~A.~C and ~A.~C+~B.~C. ...
- [STAFF] Minimum number of 2-input NANDs needed to implement arbitrary 2-input Boolean function — 8
  It seems to me the minimum number of 2-input NANDs needed to implement any arbitrary 2-input Boolean function is only 3. Reason? Th...

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