Tutorial : Minimal Sum Of Products

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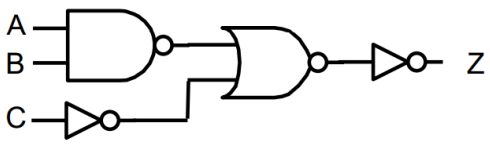
For the following problems, please use the following conventions when entering boolean expressions.

- $\bar{X}$: enter as not(X).
- X AND Y: enter as XY.
- X AND $\bar{Y}$: enter as Xnot(Y).
- X OR Y: enter as X + Y.
- $\bar{X}\bar{Y}$: enter as not(X)not(Y).
- Recall that $\overline{XY} = \bar{X} + \bar{Y}$ (not $\bar{X}\bar{Y}$).
- Extra white spaces are ignored.
- Lower or upper case letters are treated the same.
- Sum of products expression refers to an expression of the form ABC + not(A)not(B)C, where each term is a product term and ORing them together makes a sum of products expression. Note that within a product term negation can only be applied to a single variable at a time. In other words not(A)not(B) is acceptable but not(AB) is not.

Minimal Sum Of Products

0/1 point (ungraded)
Consider the following circuit that implements the 3-input function Z(A,B,C):



What is the minimal sum-of-products expression for Z(A,B,C):

not(b) + not(a)b + bc

✖ Answer: not(A) + not(B) + not(C)

Explanation
A simple way to solve this problem is to create Z's 8-row truth table from the circuit diagram above and see how many of the rows have a 1 at the output. We generate the following table:

A	B	C	$Z(A,B,C)$
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

We can see that the output is 1 unless all inputs are 1. In other words, any time there is a 0 at one of the inputs, the output is 1. So, whenever A, B, or C are 0, then Z is 1. The resulting function would then be $Z = \overline{A} + \overline{B} + \overline{C}$.
Another way to think of this problem is to notice from this table that Z describes a 3 input NAND gate which in sum-of-products notation (after applying De Morgan's Law to $Z = \overline{ABC}$) is $Z = \overline{A} + \overline{B} + \overline{C}$.

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Answers are displayed within the problem

Minimal Sum Of Products

1/1 point (ungraded)

A sum-of-products expression involving 3 variables with greater than 7 product terms can *always* be simplified to a sum-of-products expression using fewer product terms.

- (●) True
- ( ) False

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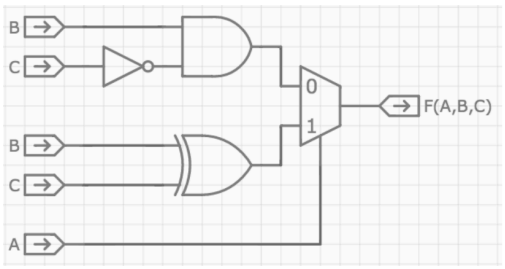
✔ Correct (1/1 point)

Minimal Sum Of Products

10 points possible (ungraded)

A 6.004 intern at Intel has designed the combinational circuit shown below. His boss can't figure out what it does and has asked for your help.



A) Your first task is to fill out F(A,B,C) in the truth table below:

A	B	C	$F(A,B,C)$
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

B) Now, express F(A,B,C) in minimal sum-of-products form. Hint: use a Karnaugh map!

Calculator

C) The boss isn't quite sure what it means but he knows his engineers are always impressed if he asks "is the circuit universal?" Is it? Choose YES or NO.

- YES
- NO

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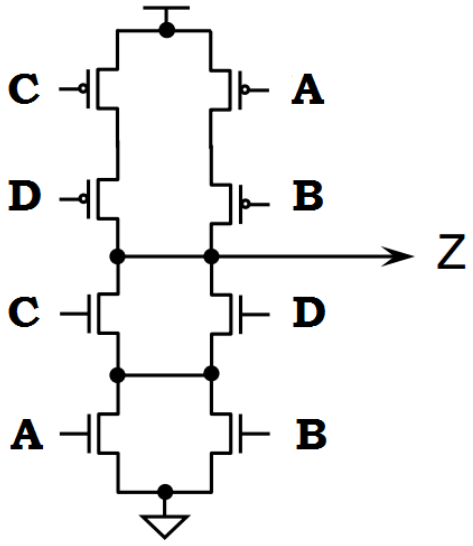
Minimal Sum Of Products

1 point possible (ungraded)

Hapless Logic, Inc has found a bunch of CMOS curcuits one of which is shown below:



Hapless Logic has forgotten what function, H(A,B,C,D), this circuit computes so they need your help. Give a Boolean sum-of-products expression for H(A,B,C,D) consistent with the pulldown shown above.

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? Can't understand q2 → c — 2
In the lecture i understand that any sum of product i can represent it using NAND NAND & NOR NOR but answer of that question tr...

Universal gate ? — 3
In Question 2 my gate ends up as XOR if A=logical 1 ...is XOR universal gate ?

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