

CSE 140 Discussion 1

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HW1: Introduction

- The purpose of this assignment is three-fold:
 - Practice the application of Boolean algebra theorems to transform and reduce Boolean expressions.
 - Go from the world of Boolean expressions to the world of digital circuits.
 - Translate a problem described in words to a Boolean algebraic expression.

Problem 2.1

- Prove DeMorgan's Law using Boolean algebra
 - $(AB)' = A' + B'$
 - $(A + B)' = A'B'$
 - Hint: To prove $LHS' = RHS$, show RHS is complement of LHS, i.e.,
 - $LHS.RHS = 0$, and
 - $LHS + RHS = 1$.

Problem 2.2

- Consensus Theorem
 - $AB + BC + A'C = AB + A'C$
 - $(A + B)(B + C)(A' + C) = (A + B)(A' + C)$
 - Use Boolean algebra to prove
 - Hint: same steps as in proving consensus theorem.

Problem 2.3

- Shannon's Expansion:
 - $f(a,b,c) = a.f(a=1,b,c) + a'.f(a=0,b,c)$
 - $f(a,b,c) = (a + f(a=0,b,c)).(a' + f(a=1,b,c))$
 - Which variable to choose?
 - Hint: Consensus theorem

Problem 3

- Problem (English) to truth table
- Truth table to Boolean algebra
 - Sum of products
 - Product of sums
- Example:
 - 3-bit input: x_1, x_2, x_3
 - Output $y = 1$ when number of 1's in input is odd and $y = 0$ otherwise.

Example

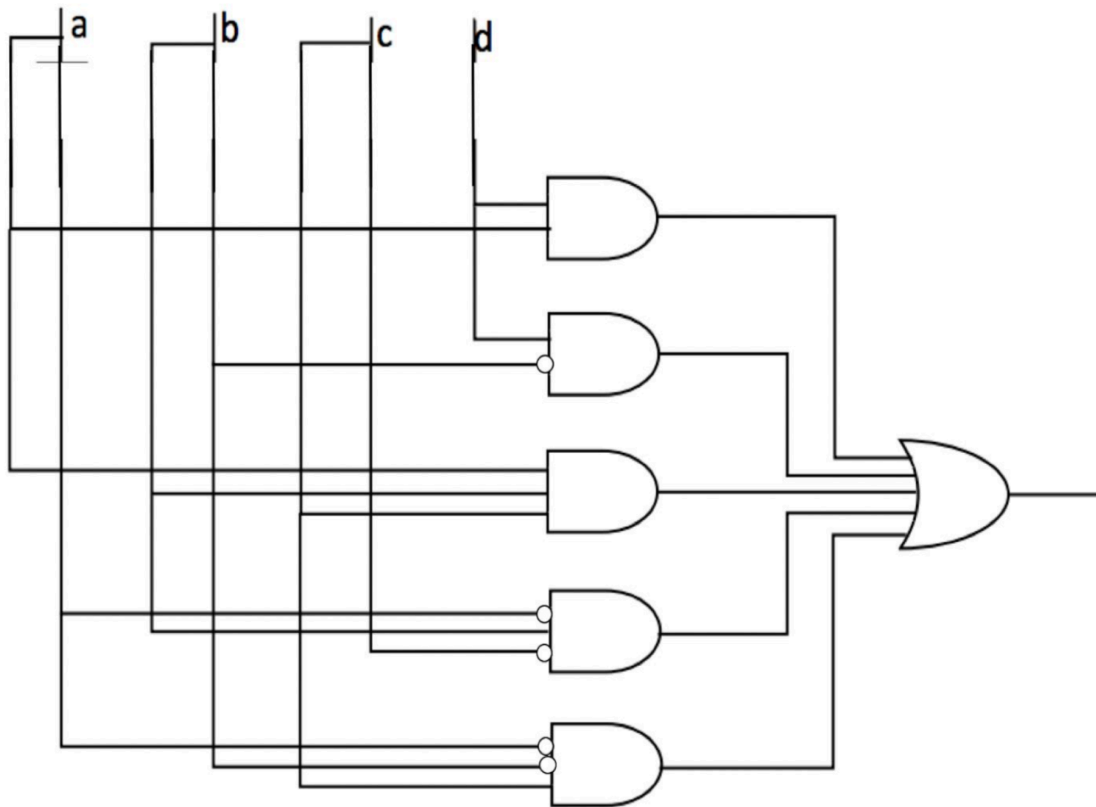
x1	x2	x3	y	minterm	MAXterm
0	0	0	0	$x'1.x'2.x'3$	$x1+x2+x3$
0	0	1	1	$x'1.x'2.x3$	$x1+x2+x'3$
0	1	0	1	$x'1.x2.x'3$	$x1+x'2+x3$
0	1	1	0	$x'1.x2.x3$	$x1+x'2+x'3$
1	0	0	1	$x1.x'2.x'3$	$x'1+x2+x3$
1	0	1	0	$x1.x'2.x3$	$x'1+x2+x'3$
1	1	0	0	$x1.x2.x'3$	$x'1+x'2+x3$
1	1	1	1	$x1.x2.x3$	$x'1+x'2+x'3$

SOP: $y = x'1.x'2.x3 + x'1.x2.x'3 + x1.x'2.x'3 + x1.x2.x3$
 POS: $y = (x1+x2+x3).(x1+x'2+x'3).(x'1+x2+x'3).(x'1+x'2+x3)$

Problem 4

- Useful tools for simplification:
- $a + ab = a$ (Absorption)
- $a + a'b$
 - add consensus: $a + a'b + b$
 - absorption: $a + b$
- $ad + bcd + a'c$
 - add consensus: $ad + bcd + a'c + cd$
 - absorption: $ad + a'c + cd$
 - remove consensus: $ad + a'c$

$$ad + b'd + a'bc' + a'b'c + abc$$



#nets: #variables + #operators

#pins: #literals + #gates*2 - 1

- #Variables:
 - 4
- #Literals:
 - 13
- #Operators:
 - 6
- #Gates:
 - 6
- #Nets:
 - 10
- #Pins:
 - 24

BSV Demo

- Problem 5
 - Test your code
- Problem 4
 - Test function equivalence