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EE101 Tutorial 7

Karnaugh Map and Function implementation using NAND/NOR

1. Simplify the following Boolean function, using three-variable maps:
   (a) $F(w,x,y,z)=\Sigma(0,1,2,5,7)$
   (b) $F(w,x,y,z)=\Sigma(0,1,6,7)$
   (c) $F(w,x,y,z)=\Sigma(1,3,5,7)$
2. Simplify the following Boolean function, using karnaugh maps:
   (a) $F(w,x,y,z)=\Sigma(2,3,6,7)$
   (b) $F(A,B,C,D)=\Sigma(3,7,11,13,14,15)$
   (c) $F(w,x,y,z)=\Sigma(1,4,5,6,7,13)$
3. Simplify the following Boolean function, using four-variable maps:
   (a) $AB'C + B'C'D' + BCD + ACD' + A'B'C + A'BC'D$
   (b) $xyz + wy + wxy' + x'y$
4. Simplify the following Boolean functions:
   (a) $F(A,B,C,D)=\Sigma(0,2,3,5,7,8,10,11,13,15)$
   (b) $F(w,x,y,z)=\Sigma(0,2,7,8,9,10,12,13,14,15)$
5. Simplify the following Boolean functions to product-of-sum form:
   (a) $F(w,x,y,z)=\Sigma(0,1,2,5,8,10,13)$
   (b) $F(A,B,C,D)=\Pi(1,3,5,6,9,11,12,14)$
6. Simplify the following Boolean function *F*, together with the don't-care conditions *d*, and then express the simplified function in sum-of-minterms form:
   (a) $F(x, y, z) = \Sigma(2, 3, 4, 6, 7)$
   $d(x,y,z)=\Sigma(0,1,5)$
   (b) $F(A, B, C, D) = \Sigma(4, 5, 6, 7, 12, 13, 14)$
   $d(A, B, C, D) = \Sigma(1, 9, 11, 15)$
7. Simplify the following functions, and implement them with two-level NAND gate circuits:
   (a) $F(A, B, C, D) = A'B'C + AC + ACD + ACD' + A'B'D' + B'CD$
   (b) $F(A, B, C) = (A' + B' + C')(A' + B')(A' + C')$
8. Simplify the following functions, and implement them with two-level NOR gate circuits:
   (a) $F = wx' + y'z' + w'yz'$
   (b) $F(w, x, y, z) = \Sigma(1, 2, 13, 14)$
   (c) $F(x, y, z) = [(x + y)(x' + z)]'$
9. Draw the multi-level NAND circuit for the following expression:

$$w(x + y + z) + xyz$$

10. Implement the following Boolean function F, together with the don't-care conditions d, using no more than two NOR gates:

$F(A, B, C, D) = \Sigma(2, 4, 6, 10, 12)$
$d(A, B, C, D) = \Sigma(0, 8, 9, 13)$