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1. Simplify the following Boolean functions, using three-variable maps:

   (a) $F(x, y, z) = \sum(0, 2, 4, 5)$
   (b) $F(x, y, z) = \sum(0, 2, 4, 5, 6)$
   (c) $F(x, y, z) = \sum(0, 1, 2, 3, 5)$
   (d) $F(x, y, z) = \sum(1, 2, 3, 7)$

   Sol:

   (a) $xy' + x'z'$
   (b) $xy' + z'$
   (c) $x' + y'z$
   (d) $x'y + x'z + yz$

2. Simplify the following Boolean functions, using three-variable maps:

   (a) $F(x, y, z) = \sum(0, 1, 5, 7)$
   (b) $F(x, y, z) = \sum(1, 2, 3, 6, 7)$

   Sol:

   (a) $x'y' + xz$
   (b) $y + x'z$

3. Simplify the following Boolean expressions, using four-variable maps:

   (a) $A'B'C'D' + AC'D' + B'CD' + A'BCD + BC'D$
   (b) $x'z + w'xy' + w(x'y + xy')$

   Sol:

   (a) $B'D' + A'BD + ABC'$
   (b) $xy' + x'z + wx'y$

4. Simplify the following Boolean expressions, using four-variable maps:

   (a) $w'z + xz + x'y + wx'z$
   (b) $AB'C + B'C'D' + BCD + ACD' + A'B'C + A'BC'D$

   Sol:

   (a) $x'y + z$
   (b) $AC + B'D' + A'BD + B'C(orCD)$

5. Find all the prime implicants for the following Boolean functions, and determine which are essential:

   (a) $F(w, x, y, z) = \sum(0, 2, 4, 5, 6, 7, 8, 10, 13, 15)$

   (b) $F(A, B, C, D) = \sum(0, 2, 3, 5, 7, 8, 10, 11, 14, 15)$

   Sol:

   (a)
   $$F = xz + x'z' + (w'x \text{ or } w'z')$$
   Essential: xz and $x'z'$; Nonessential: $w'x$ and $w'z'$

   (b)
   $$F = B'D' + AC + A'BD + (CD \text{ or } B'C)$$
   $B'D'$ and AC and $A'BD$ are essential prime implicants. CD and $B'C$ are nonessential.

6. Simplify the following Boolean functions:
   $F(A, B, C, D) = \prod(1, 3, 5, 7, 13, 15)$
   Sol:
   $F = (A + D')(B' + D')$

7. Simplify the following expressions to (1) sum-of-products and (2) products-of-sums:
   $x'z' + y'z' + yz' + xy$
   Sol:
   $F = xy + z' = (x + z')(y + z')$

8. Draw a NAND logic diagram that implements the complement of the following function:
   $F(A, B, C, D) = \sum(0, 1, 2, 3, 6, 10, 11, 14)$
   Sol: $F' = AC' + BC' + BD$

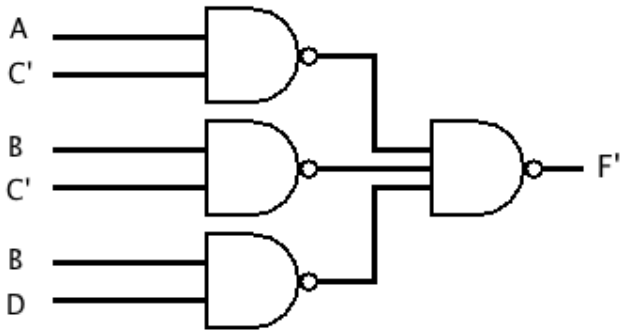

Figure 1: diagram