DPCO Assignment / Tutorial Practice Problems – Part 2

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

   (a) $F(x, y, z) = \Sigma(0, 2, 3, 7)$

   (b) $F (x, y, z) = \Sigma(2, 3, 5, 6, 7)$

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

   (a) $F(x, y, z) = x'y'z + xyz' + x'yz + xyz$

   (b) $F(x, y, z) = xyz' + y'z' + xz$

3. Simplify the following Boolean functions, using K-maps:

   (a) $F (w, x, y, z) = \Sigma(0, 1, 4, 5, 8, 12)$

   (b) $F (w, x, y, z) = \Sigma(4, 6, 9, 11, 12, 14)$

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

   (a) $ABC'D' + AB'C + B'C'D' + AB'CD + B'C'D$

   (b) $w'x'y' + w'x'yz + x'y'z + xyz + y'z'$

5. Find the minterms of the following Boolean expressions by first plotting each function in a K-map:

   (a) $w'x + xz + wyz$

   (b) $ABD' + BC'D + CD$

6. Using K-maps for F and F′, convert the following Boolean function from a sum-of-products form to a simplified product-of-sums form.

   $F (w, x, y, z) = \Sigma(1, 2, 4, 5, 9, 10, 13, 14)$

7. Simplify the following Boolean functions:

   (a) $F (A, B, C, D) = \Pi(0, 1, 6, 7, 8, 10, 12, 14)$

8. Simplify the following expressions to (1) sum-of-products and (2) products-of-sums:

   (a) $x'y'z' + yz' + xy$

   (b) $A'B + A'B'C + CD$

9. Give three possible ways to express the following Boolean function with a fewer number of literals:

   $A'B'C' + A'CD + A'C'D' + A'BD + ABC + AB'C$

10. 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) $F (x, y, z) = \Sigma(0, 3,5)$, $d(x, y, z) = \Sigma(1, 6, 7)$

    (b) $F (A, B, C, D) = \Sigma(1, 2, 4, 6, 12)$, $d(A, B, C, D) = \Sigma(0, 3, 5, 7, 11, 15)$

11. Simplify the following functions, and implement them with two-level NAND gate circuits:

    (a) $F (A, B, C, D) = A'B'C + A'BC + ABC$

    (b) $F (A, B, C, D) = A'CD' + A'BD + ABD + AB'CD$

12. Draw

    (a) A NAND logic diagram that implements the complement of the following function:

    F (A, B, C, D) = $\Sigma(0, 2, 4, 5, 8, 9, 10, 11)$, and

    (b) Repeat for a NOR logic diagram.

13. Draw

    (a) a logic diagram using only two-input NOR gates to implement the following function:

    F (A, B, C, D) = (A EX-OR B)′(C EX-OR D), and

    (b) repeat for a NAND logic diagram.

14. Simplify the following functions, and implement them with two-level NOR gate circuits:

    (a) $F(w, x, y, z) = wx'y' + wy'z' + xy'$

    (b) $F(w, x, y, z) = \Sigma(0, 2, 8, 9, 10, 11, 14)$

    (c) $F(x, y, z) = [(x' + y)(y + z')]'$

15. Draw

    (a) the multiple-level NOR circuit for the following expression:

    $CD(B + C)A + (BC' + DE')$, and

    (b) repeat (a) for a NAND circuit.

16. 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) = $\Sigma(2, 4, 10, 12, 14,)$

    d(A, B, C, D) = $\Sigma(0, 1, 5, 8)$. Assume that both the normal and complement inputs are available.

17. Implement the following Boolean function F, using the two-level forms of logic (a) NAND-AND, (b) AND-NOR, (c) OR-NAND, and (d) NOR-OR:

    F (A, B, C, D) = $\Sigma(0, 4, 8, 9, 10, 11, 12, 14)$

18. List the eight degenerate two-level forms and show that they reduce to a single operation. Explain how the degenerate two-level forms can be used to extend the number of inputs to a gate.

    Sol: AND-AND, AND-OR, AND-NAND, AND-NOR,

    OR-AND, OR-OR, OR-NAND, OR-NOR,

    NAND-AND, NAND-OR, NAND-NAND, NAND-NOR,

    NOR-AND, NOR-OR, NOR-NAND, NOR-NOR.

19. Implement the following Boolean expression with exclusive-OR and AND gates:

    $F = AB'CD' + A'BC\,D' + AB'C'D + A'BC'D$

20. Implement the following Boolean expression with Exclusive-NOR and AND gates:
    $F = A'B'C'D' + ABC'D' + A'B'CD + ABCD$

21. With the use of maps, find the simplest sum-of-products form of the function F = fg , where
    $f = abc' + b'd' + a'd' + b'cd'$ and $g = (a + b + c' + d')(a' + b' + d)(a' + d')$